PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-140048
(43)Date of publication of application : 14.05.2003

(51)Int.Cl. G02B 15/20
G02B 7/04
G02B 7/10
G02B 13/18

(21)Application number : 2001-334771
(22)Date of filing : 31.10.2001

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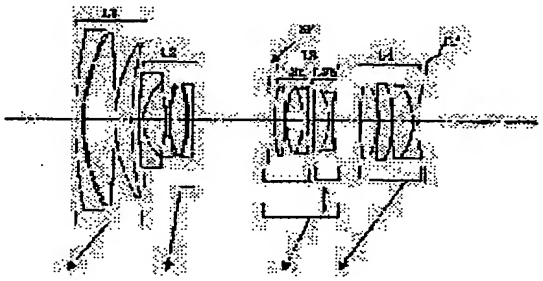
(54) ZOOM LENS AND OPTICAL EQUIPMENT PROVIDED WITH THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a zoom lens for obtaining a still image by optically correcting image blurring caused by the vibration of the zoom lens, and to obtain optical equipment provided with the zoom lens.
SOLUTION: The zoom lens is provided with a 1st lens group having a positive refractive power, a 2nd lens group having a negative refractive power, a 3rd lens group having a positive refractive power and a 4th lens group having a positive refractive power in this order from an object side, and the power is varied by changing a distance between respective lens groups, the 3rd lens group is provided with a 3rd-a lens group having a positive refractive power and a 3rd-b lens group having a negative refractive power, and the image forming position is shifted by moving the 3rd-b lens group so as to have a component vertical to the optical axis, and each distance DiW and Dit between an i-th lens group and an (i-th+1) lens group at a wide angle end and a telephoto end, the focal distance fT of the whole system at the telephoto end and the focal distance f2 of the 2nd lens group are appropriately set.



LEGAL STATUS

[Date of request for examination] 29.09.2004

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]
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CLAIMS

[Claim(s)]
[Claim 1] In order [side / body], the 1st lens group of forward refractive power, and the 2nd lens group of negative refractive power, In the zoom lens which it has the 3rd lens group of forward refractive power, and the 4th lens group of forward refractive power, and spacing of each lens group is changed, and performs variable power this 3rd lens group It has 3b lens group. the [of forward refractive power] — the [of 3a lens group and negative refractive power] — The variation rate of the image formation location is carried out by moving 3b lens group so that it may have an optical axis and a vertical component. the [this] — When making spacing of the i-th lens group in a wide angle edge and a tele edge, and a ** (i+1) lens group, and fT into the focal distance of the whole system in a tele edge and making f2 into the focal distance of this 2nd lens group for DiW and DiT respectively, The zoom lens characterized by satisfying the conditional expression of D1 W<D1TD2 W>D2TD3 W>D3T0.04<|f2/fT|<0.1.
[Claim 2] f3a and f3b — the [each aforementioned] — the [3a lens group and], when making the focal distance of 3b lens group, and f4 into the focal distance of said 4th lens group and making LW into the optical overall length in a wide angle edge The zoom lens of claim 1 characterized by satisfying the conditional expression of 1.5<|f3 b/f3a|<2.50.2<f4/fT<0.40.5<LW/fT<0.81.5<(D1 T-D1W)/(D2 W-D2T) <3.0.
[Claim 3] the [said] — the zoom lens of claim 1 characterized by 3b lens group consisting of one positive lens and one negative lens.
[Claim 4] the [said] — the time of setting the spherical-aberration multiplier of 3b lens group to I3b — I3b>0 — the zoom lens of claim 1 characterized by satisfying conditional expression.
[Claim 5] the [said] — the zoom lens of claim 1 characterized by 3a lens group consisting of two positive lenses and one negative lens.
[Claim 6] Said 2nd lens group is the zoom lens of claim 1 characterized by having three negative lenses and one positive lens.
[Claim 7] Said 1st lens group is the zoom lens of claim 1 characterized by consisting of a meniscus-like negative lens and two positive lenses.
[Claim 8] Said 4th lens group is the zoom lens of claim 1 characterized by having the aspheric surface of a configuration where forward refractive power becomes weak as it goes to the lens circumference from a lens core.
[Claim 9] Said 4th lens group is the zoom lens of claim 1 characterized by consisting of three positive lenses and one negative lens in order [side / body].
[Claim 10] the [said] — the zoom lens of claim 1 characterized by 3b lens group having the aspheric surface of a configuration which goes to the lens circumference from a lens core, and where it is alike, and it follows and forward refractive power becomes weak.
[Claim 11] the [said] — the zoom lens of claim 1 characterized by 3b lens group consisting of the negative lens separated with a positive lens and this positive lens, and air spacing.
[Claim 12] the [said] — 3b lens group — the cemented lens of a positive lens and a negative lens — changing — the radius of curvature of the cemented lens side of this cemented lens — the [Rb and / this] — the time of setting the focal distance of 3b lens group to f3b — 0.22<Rb/f3 — claim 1 characterized by satisfying the conditional expression of b< 0.29, or the

zoom lens of 2.
[Claim 13] In order [side / body], the 1st lens group of forward refractive power, and the 2nd lens group of negative refractive power, In the zoom lens which it has the 3rd lens group of forward refractive power, and the 4th lens group of forward refractive power, and spacing of each lens group is changed, and performs variable power this 3rd lens group It has 3b lens group. the [of forward refractive power] — the [of 3a lens group and negative refractive power] — The variation rate of an image formation location is performed by moving 3b lens group so that it may have an optical axis and a vertical component. the [this] — DiW and DiT — spacing of the i-th lens group in an each wide angle edge and a tele edge, and a ** (i+1) lens group, and fT — the focal distance of the whole system in a tele edge, and f2 — the focal distance of this 2nd lens group, f3a, and f3b — the [each this] — with 3a lens group the, when making the focal distance of 3b lens group, and f4 into the focal distance of this 4th lens group and making LW into the optical overall length in a wide angle edge D1 W<D1TD2 W>D2TD3 W>D3T0.04<|f2/fT|<0.11.5<|f3 b/f3a|<2.50.2<f4/fT<0.40.5 The zoom lens characterized by satisfying one or more conditional expression among the conditional expression of <LW/fT<0.81.5<(D1 T-D1W)/(D2 W-D2T) <3.0.
[Claim 14] the — 3b lens group — the cemented lens of a positive lens and a negative lens — changing — the radius of curvature of the cemented lens side of this cemented lens — the [Rb and / this] — the time of setting the focal distance of 3b lens group to f3b — 0.22<Rb/f3 — the zoom lens of claim 13 characterized by satisfying the conditional expression of b< 0.29.
[Claim 15] The zoom lens of any 1 term of claims 1-14 characterized by being the optical system for forming an image on an image sensor.
[Claim 16] The optical instrument characterized by having the image sensor which receives the image formed by the zoom lens and this zoom lens of any 1 term of claims 1-15.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is suitable for optical instruments, such as a film photo camera which amended image blurring (image blurring) when some lens groups of optical system are moved in more detail about the optical instrument which has a zoom lens and it so that it may have a vertical component to an optical axis, and a zoom lens vibrates (tilt) good, having high optical-character ability, a video camera, an electronic "still" camera, and a digital camera.
[0002]
[Description of the Prior Art] In the photography from a migration body, vibration arises in a photography system (taking lens), and Bure arises an on-going vehicle etc. in a propagation photography image. Moreover, in stock photography with a taking lens with a long focal distance, or the large taking lens of the f number (FNo), Bure (image Bure) may arise in a photography image by blurring. In recent years, the film-based camera with the vibrationproofing function which amended these image Bure optically or electrically, the video camera, the digital camera, etc. are proposed.
[0003] The zoom lens with a vibrationproofing function is proposed from before by JP,5-232410,A (conventional example 1), JP,8-136863,A (conventional example 2), publication number 8-106047 (conventional example 3), JP,9-230237,A (conventional example 4), etc. Among these, from the body side, the conventional example 1 is the looking-far zoom lens which consisted of four lens groups, forward, negative, forward, and forward refractive power, in order, moves the 2nd lens group to an optical axis and a perpendicular direction, and is performing vibrationproofing. From the body side, the conventional example 2 is a zoom lens which consists of five lens groups, forward, negative, forward, forward, and negative refractive power, in order, moves a part of 2nd lens group to an optical axis and a perpendicular direction, and is performing vibrationproofing. From the body side, the conventional example 3 is a zoom lens which consists of five lens groups, forward, negative, forward, forward, and negative refractive power, in order, moves a part of 4th lens group to an optical axis and a perpendicular direction, and is performing vibrationproofing. From the body side, the conventional example 4 is a zoom lens with four lens groups, forward, negative, forward, and forward refractive power, moves some lens groups in a lens group to an optical axis and a perpendicular direction, and is performing vibrationproofing in order.
[0004] The 1st lens group which has forward refractive power from a body side in JP,11-237550,A, The 2nd lens group which has negative refractive power, the 3rd lens group which has forward refractive power, Have the 4th lens group which has forward refractive power, move this 2nd and 4th lens group on an optical axis, and variable power is performed. This 3rd lens group has the 31st lens group and the 32nd lens group, and is indicating the zoom lens which is performing the variation rate of an image formation location by moving this 32nd lens group perpendicularly to an optical axis.
[0005]
[Problem(s) to be Solved by the Invention] In the optical system which the parallel eccentricity of some lenses of a photography system is made to carry out perpendicularly to an optical axis,

and generally amends image blurring, although there is an advantage which can amend image blurring comparatively easily, the driving means for the lens to which it is made to move is needed, and there is a trouble that the yield of the eccentric aberration at the time of vibrationproofing increases.

[0006] For example, big torque is needed, in case an electric drive is performed as the amendment optical system which amends image blurring has much lens configuration number of sheets and is the amount of Takashige. Moreover, if the correcting lens group for amending image blurring is not set up appropriately, in order to acquire the amendment effectiveness of image blurring of a constant rate, it will be necessary to take many movement magnitude of amendment optical system, and there is a problem that the whole optical system is enlarged.

[0007] if the amendment effectiveness of an image over migration of amendment optical system is strengthened, in order to, perform exact amendment to fixed image blurring amendment on the other hand — eccentricity — receiving — image formation — a variation rate — since an operation becomes sensitive too much, it becomes difficult to perform exact lens migration control.

[0008] By arranging amendment optical system for image blurring amendment appropriately, this invention controls movement magnitude of the amendment optical system for performing miniaturization of amendment optical system, and the image blurring amendment effectiveness of a constant rate easily, maintaining high definition, and aims at offer of the optical instrument which has the zoom lens and it which can perform the electric drive of amendment optical system easily.

[0009] In addition, this invention covers from a wide angle region with a focal distance of about 28mm to an about 200mm looking-far region by 35mm single-lens reflex camera conversion, and aims at offer of the optical instrument which has the zoom lens with which it was compact with the zoom lens and especially the aberration at the time of vibrationproofing was also amended good and it which have a vibrationproofing function.

[0010]

[Means for Solving the Problem] In order [side / body], the zoom lens of invention of claim 1 The 1st lens group of forward refractive power, It has the 2nd lens group of negative refractive power, the 3rd lens group of forward refractive power, and the 4th lens group of forward refractive power. In the zoom lens which spacing of each lens group is changed and performs variable power this 3rd lens group It has 3b lens group. the [of forward refractive power] — the [of 3a lens group and negative refractive power] — The variation rate of the image formation location is carried out by moving 3b lens group so that it may have an optical axis and a vertical component. the [this] — When making spacing of the i-th lens group in a wide angle edge and a tele edge, and a ** (i+1) lens group, and fT into the focal distance of the whole system in a tele edge and making f2 into the focal distance of this 2nd lens group for DiW and DiT respectively, It is characterized by satisfying the conditional expression of D1 W<D1TD2 W>D2TD3 W>D3T0.04<|f2/fT|<0.1.

[0011] invention of claim 2 — invention of claim 1 — setting — f3a and f3b — the [each aforementioned] — the [3a lens group and], when making the focal distance of 3b lens group, and f4 into the focal distance of said 4th lens group and making LW into the optical overall length in a wide angle edge It is characterized by satisfying the conditional expression of 1.5<|f3 b/f3a|<2.50.2<f4/fT<0.40.5<LW/fT<0.81.5<(D1 T-D1W)/(D2 W-D2T) <3.0.

[0012] invention of claim 3 — invention of claim 1 — setting — the [said] — 3b lens group is characterized by consisting of one positive lens and one negative lens.

[0013] invention of claim 4 — invention of claim 1 — setting — the [said] — the time of setting the spherical-aberration multiplier of 3b lens group to I3b — I3b>0 — it is characterized by satisfying conditional expression.

[0014] invention of claim 5 — invention of claim 1 — setting — the [said] — 3a lens group is characterized by consisting of two positive lenses and one negative lens.

[0015] Invention of claim 6 is characterized by said 2nd lens group having three negative lenses and one positive lens in invention of claim 1.

[0016] Invention of claim 7 is characterized by said 1st lens group consisting of a meniscus-like

negative lens and two positive lenses in invention of claim 1.
[0017] Invention of claim 8 is characterized by having the aspheric surface of a configuration where forward refractive power becomes weak as said 4th lens group goes to the lens circumference from a lens core in invention of claim 1.
[0018] Invention of claim 9 is characterized by said 4th lens group consisting of three positive lenses and one negative lens in order [side / body] in invention of claim 1.
[0019] invention of claim 10 — invention of claim 1 — setting — the [said] — 3b lens group is characterized by having the aspheric surface of a configuration which goes to the lens circumference from a lens core and where it is alike, and it follows and forward refractive power becomes weak.
[0020] invention of claim 11 — invention of claim 1 — setting — the [said] — 3b lens group is characterized by consisting of the negative lens separated with a positive lens and this positive lens, and air spacing.
[0021] invention of claim 12 — claim 1 or invention of 2 — setting — the [said] — 3b lens group — the cemented lens of a positive lens and a negative lens — changing — the radius of curvature of the cemented lens side of this cemented lens — the [Rb and / this] — the time of setting the focal distance of 3b lens group to f3b — 0.22 — < — it is characterized by satisfying the conditional expression of Rb/f3b<0.29.
[0022] In order [side / body], the zoom lens of invention of claim 13 The 1st lens group of forward refractive power, It has the 2nd lens group of negative refractive power, the 3rd lens group of forward refractive power, and the 4th lens group of forward refractive power. In the zoom lens which spacing of each lens group is changed and performs variable power this 3rd lens group It has 3b lens group. the [of forward refractive power] — the [of 3a lens group and negative refractive power] — The variation rate of an image formation location is performed by moving 3b lens group so that it may have an optical axis and a vertical component. the [this] — DiW and DiT — spacing of the i-th lens group in an each wide angle edge and a tele edge, and a ** (i+1) lens group, and fT — the focal distance of the whole system in a tele edge, and f2 — the focal distance of this 2nd lens group, f3a, and f3b — the [each this] — with 3a lens group the, when making the focal distance of 3b lens group, and f4 into the focal distance of this 4th lens group and making LW into the optical overall length in a wide angle edge D1 W<D1TD2 W>D2TD3 W>D3T0.04<|f2/fT|<0.11.5<|f3 b/f3a|<2.50.2<f4/fT<0.40 . It is characterized by satisfying one or more conditional expression among the conditional expression of 5<LW/fT<0.81.5<(D1 T-D1W)/(D2 W-D2T) <3.0.
[0023] invention of claim 14 — invention of claim 13 — setting — the — 3b lens group — the cemented lens of a positive lens and a negative lens — changing — the radius of curvature of the cemented lens side of this cemented lens — the [Rb and / this] — the time of setting the focal distance of 3b lens group to f3b — 0.22 — < — it is characterized by satisfying the conditional expression of Rb/f3b<0.29.
[0024] Invention of claim 15 is characterized by being the optical system for forming an image on an image sensor in invention of claims 1-14.
[0025] The optical instrument of invention of claim 16 is characterized by having the image sensor which receives the image formed by the zoom lens and this zoom lens of any 1 term of claims 1-15.
[0026]
[Embodiment of the Invention] A lens sectional view [in / in drawing 1 / the wide angle edge of the zoom lens of the operation gestalt 1], drawing 2 , a longitudinal aberration Fig. [in / in drawing 3 / the wide angle edge of the zoom lens of the operation gestalt 1 and a tele edge], drawing 4 , a transverse aberration Fig. [in / in drawing 5 / wide angle edge of the zoom lens of the operation gestalt 1 and a tele edge], drawing 6 , and drawing 7 are a transverse aberration Fig., after changing the image position equivalent to 0.3 degrees of the field angle in the wide angle edge of the zoom lens of the operation gestalt 1, and a tele edge.
[0027] A lens sectional view [in / in drawing 8 / the wide angle edge of the zoom lens of the operation gestalt 2], drawing 9 , a longitudinal aberration Fig. [in / in drawing 10 / the wide angle edge of the zoom lens of the operation gestalt 2 and a tele edge], drawing 11 R> 1, a

transverse aberration Fig. [in / in drawing 12 / the wide angle edge of the zoom lens of the operation gestalt 2 and a tele edge], drawing 13 , and drawing 14 are a transverse aberration Fig., after changing the image position equivalent to 0.3 degrees of the field angle in the wide angle edge of the zoom lens of the operation gestalt 2, and a tele edge.
[0028] A lens sectional view [in / in drawing 15 / the wide angle edge of the zoom lens of the operation gestalt 3], drawing 16 , a longitudinal aberration Fig. [in / in drawing 17 / the wide angle edge of the zoom lens of the operation gestalt 3 and a tele edge], drawing 1818 , a transverse aberration Fig. [in / in drawing 19 / the wide angle edge of the zoom lens of the operation gestalt 3 and a tele edge], drawing 20 , and drawing 21 are a transverse aberration Fig., after changing the image position equivalent to 0.3 degrees of the field angle in the wide angle edge of the zoom lens of the operation gestalt 3, and a tele edge.
[0029] A lens sectional view [in / in drawing 22 / the wide angle edge of the zoom lens of the operation gestalt 4], drawing 23 , a longitudinal aberration Fig. [in / in drawing 24 / the wide angle edge of the zoom lens of the operation gestalt 4 and a tele edge], drawing 2525 , a transverse aberration Fig. [in / in drawing 26 / the wide angle edge of the zoom lens of the operation gestalt 4 and a tele edge], drawing 27 , and drawing 28 are a transverse aberration Fig., after changing the image position equivalent to 0.3 degrees of the field angle in the wide angle edge of the zoom lens of the operation gestalt 4, and a tele edge.
[0030] A lens sectional view [in / in drawing 29 / the wide angle edge of the zoom lens of the operation gestalt 5], drawing 30 , a longitudinal aberration Fig. [in / in drawing 31 / the wide angle edge of the zoom lens of the operation gestalt 5 and a tele edge], drawing 3232 , a transverse aberration Fig. [in / in drawing 33 / the wide angle edge of the zoom lens of the operation gestalt 5 and a tele edge], drawing 34 , and drawing 35 are a transverse aberration Fig., after changing the image position equivalent to 0.3 degrees of the field angle in the wide angle edge of the zoom lens of the operation gestalt 5, and a tele edge.
[0031] In a lens sectional view, the 1st lens group of refractive power forward in L1, the 2nd lens group of refractive power negative in L2, the 3rd lens group of refractive power forward in L3, and L4 are the 4th lens groups of forward refractive power. An arrow head shows the migration direction of each lens group at the time of performing variable power from a wide angle side to a looking-far side. SP has prepared between the 2nd lens group and the 3rd lens group by the diaphragm. IP is the image surface. FP is a flare cut diaphragm.
[0032] the [of refractive power forward in the 3rd lens group L3] — the [of the negative refractive power which moves so that it may have an optical axis and a vertical component for 3a lens group L3a and vibrationproofing] — it has 3b lens group L3b. in addition, the diaphragm SP — the — it is united with 3a lens group.
[0033] In the zoom lens of each operation gestalt, it has the 1st lens group L1 which has forward refractive power from a body side, the 2nd lens group L2 which has negative refractive power, the 3rd lens group L3 which has forward refractive power, and the 4th lens group L4 which has forward refractive power. air spacing of each lens group is changed performing migration on an optical axis for each lens group — making — variable power — carrying out — the [of the negative refractive power in said 3rd lens group] — the image formation location is changed by moving 3b lens group L3b so that it may have a vertical component to an optical axis.
[0034] A variable power operation is mainly performed by the 2nd lens group L2 by changing air spacing of the 1st lens group L1 and the 2nd lens group L2 on the occasion of variable power. Fluctuation of the aberration outside a shaft accompanying variable power is amended by changing air spacing of the 3rd lens group L3 and the 4th lens group L4 at the same time it performs an amendment operation of the image surface mainly changed in connection with variable power by migration of the 3rd lens group L3. the [and / of refractive power negative to the inside of the 3rd lens group L3 which has forward refractive power] — arranging 3b lens group L3b — the [in the 3rd lens group L3] — many aberration generated by the lens group of a forward refraction operation among lens systems other than 3b lens group L3b — the — it has canceled in the negative refraction operation of 3b lens group L3b. Moreover, the displacement operation of a large image position is performed to it and coincidence with small movement magnitude.

[0035] The focus from an infinite distance body to a short-distance body is performed by moving the 1st lens group L1 or the 2nd lens group L2 to a body side. Especially the method to which the 2nd lens group L2 is moved is good in order not to increase the lens outer diameter of the 1st lens group L1. Moreover, a focus may be performed by moving both the 1st and 2nd lens groups L1 and L2 to a body side.
[0036] The zoom lens of each operation gestalt has four lens groups of the refractive power mentioned above. The variation rate of an image formation location is performed by moving 3b lens group so that it may have an optical axis and a vertical component. spacing each lens between groups is changed — making — variable power (zooming) — carrying out — the — DiW and DiT — spacing of the i-th lens group in an each wide angle edge and a tele edge, and a ** (i+1) lens group, and fT — the focal distance of the whole system in a tele edge, and f2 — the focal distance of this 2nd lens group L2, f3a, and f3b — the [each this] — with 3a lens group L3a the — time of making the focal distance of 3b lens group L3b, and f4 into the focal distance of this 4th lens group L4, and making LW into the optical overall length in a wide angle edge D1 W<D1T ... (1)
D2 W>D2T ... (2)
D3 W>D3T ... (3)
0.04<|f2/fT|<0.1 ... (4)
1.5<|f3 b/f3a|<2.5 ... (5)
0.2<f4/fT<0.4 ... (6)
0.5<LW/fT<0.8 ... (7)
1.5<(D1 T-D1W)/(D2 W-D2T) <3.0 ... (8)
He is trying to satisfy one or more conditional expression among ********. the [moreover,] — the time of setting the spherical-aberration multiplier of 3b lens group L3b to I3b — I3b>0 ... (9)
It is made to be satisfied. the [moreover,] — the time of 3b lens group L3b consisting of the cemented lens of a positive lens and a negative lens — the radius of curvature of the cemented lens side of this cemented lens — the [Rb and / this] — time of setting the focal distance of 3b lens group L3b to f3b 0.22 <Rb/f3b — < — 0.29 ... (10)
He is trying to satisfy ********.
[0037] Next, the technical semantics of the above-mentioned monograph affair type is explained.

[0038] Each lens group is moving so that it may be satisfied with each operation gestalt of conditional-expression (1) - (3) on the occasion of the variable power of a tele edge from a wide angle edge. drawing SP — variable power — facing — the — it is moving united with 3a lens group L3a.
[0039] The utilization ratio of space often performs variable power in the 2nd lens group L2, and shortens the optical overall length (die length from the 1st lens side to the image surface) in a wide angle edge because the 1st lens group L1 and the 2nd lens group L2 move to a body side on the occasion of the variable power from a wide angle edge to a tele edge, satisfying conditional expression (1) and (2). Moreover, in a wide angle side, it considers as a retro type as the lens whole system, the back focus of required die length is secured, and miniaturization of the whole lens system is attained as a tele photograph type as the lens whole system in the looking-far side. Furthermore, the variable power effectiveness in the 3rd lens group L3 and the 4th lens group L4 is heightened by moving more the principal point location of composition of the 3rd lens group L3 and the 4th lens group L4 to a body side in connection with the variable power from a wide angle edge to a tele edge by moving the 3rd lens group L3 and the 4th lens group L4 to a body side, satisfying conditional expression (3).
[0040] stationing drawing SP in the 3rd lens group L3 — the diameter of a diaphragm — small — stopping — a front ball diameter — namely, — most — the diameter of a lens by the side of a body, and a back ball diameter — that is, the diameter of a lens by the side of the image surface is most made into suitable magnitude, and miniaturization of the lens whole system is attained.
[0041] Conditional expression (4) is a formula for using a lens system as a compact, maintaining the mainly good engine performance about the ratio of the focal distance of the whole system in the 2nd lens group and a tele edge. Although it is advantageous to miniaturization if the negative

refractive power of the 2nd lens group becomes strong exceeding the lower limit of conditional expression (4), it becomes difficult for many aberration generated by the 2nd lens group to become large, and to amend this with sufficient balance by other lens groups. A lens system increases and is not desirable although it is advantageous to aberration amendment, if the negative refractive power of the 2nd lens group becomes weak exceeding the upper limit of conditional expression (4).

[0042] conditional expression (5) — the — the [to the focal distance of 3a lens group L3a] — it is a formula for obtaining required vibrationproofing sensitivity, specifying the range of the focal distance of 3b lens group L3b, and maintaining good optical-character ability. the time of using as a vibrationproofing angle the include angle of the shaft which connected the optical-axis core of the lens side by the side of a body to the object point in front of a hand deflection most with vibrationproofing sensitivity, and the shaft to which the optical-axis core of the lens side by the side of a body was most connected with the object point at the time of a hand deflection here — a vibrationproofing lens group, the [i.e.,], — it is a vibrationproofing angle per movement magnitude of 1mm to the optical axis of 3b lens group L3b, and a vertical component. the minimum of conditional expression (5) — exceeding — the — aberration amendment becomes difficult, although it is advantageous to miniaturization and energy saving since the energy at the time of there being few tooth spaces for migration of a vibrationproofing lens group, and ending, and driving a vibrationproofing lens group by a motor etc., since the movement magnitude of the vibrationproofing lens group for vibrationproofing sensitivity becoming large and acquiring a required vibrationproofing angle will become small if the negative refractive power of 3b lens group L3b becomes strong is small and ends. the upper limit of conditional expression (5) — exceeding — the — although it will become advantageous to aberration amendment if the negative refractive power of 3b lens group L3b becomes weak, it becomes disadvantageous for miniaturization and energy saving.

[0043] Aberration amendment becomes difficult although conditional expression (6) is advantageous to compaction of a lens overall length, if the ratio of the focal distance of the 4th lens group L4 to the focal distance of the whole system in a tele edge is specified and the forward refractive power of the 4th lens group L4 becomes strong exceeding the lower limit of conditional expression (6). Although it is advantageous to aberration amendment if the forward refractive power of the 4th lens group L4 becomes weak exceeding the upper limit of conditional expression (6), a lens system increases.

[0044] It is the ratio of the die length from the lens side by the side of a body (the 1st lens side) to the image surface most, and since [in a wide angle edge / as opposed to the focal distance of the whole system in a tele edge in conditional expression (7)] it will be necessary to strengthen refractive power of each lens group if miniaturization is attained exceeding the lower limit of conditional expression (7), optical-character ability deteriorates. If the upper limit of conditional expression (7) is exceeded, it will be contrary to miniaturization.

[0045] Conditional expression (8) is the ratio of the spacing variation of the spacing variation of the 1st lens group L1 from a wide angle edge to a tele edge, and the 2nd lens group L2, the 2nd lens group L2, and the 3rd lens group L3, and is for making small the path of the diaphragm arranged at the 3rd lens group L3, and making the path of each lens group the optimal. That the spacing variation of the 1st lens group L1 and the 2nd lens group L2 becomes small to the spacing variation of the 2nd lens group L2 and the 3rd lens group L3 exceeding the lower limit of conditional expression (8) in order to obtain a predetermined variable power ratio It means that the spacing variation of the 2nd lens group L2 and the 3rd lens group L3 becomes large, and in order for spacing of the diaphragm and the 1st lens group L1 in a wide angle edge to become large and to secure the quantity of light to the circumference of a screen, the path of the 1st lens group L1 increases. If the spacing variation of the 1st lens group L1 and the 2nd lens group L2 becomes large to the spacing variation of the 2nd lens group L2 and the 3rd lens group L3 exceeding the upper limit of conditional expression (8), in order to secure the quantity of light to the circumference of a screen by the side of looking far shortly, the path of the 1st lens group L1 increases.

[0046] Conditional expression (9) is a thing for keeping good the optical-character ability at the

time of vibrationproofing, and if conditional expression (9) is not satisfied, it will become difficult to keep good the optical-character ability at the time of vibrationproofing.
[0047] conditional expression (10) — the — it is a thing for amending many aberration which kept suitable the radius of curvature of the cemented lens side when constituting 3b lens group L3b from a cemented lens, and includes chromatic aberration with sufficient balance.
[0048] each operation gestalt — setting — a vibrationproofing lens group, the [i.e.,], — 3b lens group L3b is constituted from one positive lens and one negative lens, and aberration amendment is performed good, attaining lightweight-ization of a vibrationproofing lens group.
[0049] Moreover, said 1st lens group L1 was constituted from a meniscus-like negative lens and two positive lenses, said 2nd lens group L2 was constituted from three negative lenses and one positive lens, and the zoom lens of compact and good optical-character ability is attained by using the aspheric surface of a configuration where forward refractive power becomes weak as it goes for said 4th lens group L4 to the lens circumference from a lens core.
[0050] Moreover, with the operation gestalten 1, 2, 4, and 5, the 4th lens group L4 was constituted from three positive lenses and one lens from the body side, and small lens number of sheets has attained compact and good optical-character ability.
[0051] moreover, in order to keep good the optical-character ability at the time of vibrationproofing, conditional expression (9) is satisfied — as — the — the suitable lens configuration is given using the suitable ** material for 3b lens group L3b. moreover — the operation gestalten 1, 2, and 3 — the [said] — the aspheric surface of a configuration which goes for 3b lens group L3b to the lens circumference from a lens core and where it is alike, and it follows and forward refractive power becomes weak — using — the operation gestalt 4 — the [said] — 3b lens group L3b consists of negative lenses separated with a positive lens and this positive lens, and air spacing. and — the operation gestalten 1, 2, 3, and 5 — the [said] — 3b lens group L3b was used as the cemented lens of a positive lens and a negative lens, and conditional expression (10) is satisfied.
[0052] In addition, it is good to set up the numerical range of conditional-expression (4) - (8) and (10) as following still more preferably.
[0053]
0.06<|f2/fT|<0.09 ... (4a)
1.7<|f3 b/f3a|<2.3 ... (5a)
0.23<f4/fT<0.35 ... (6a)
0.6<LW/fT<0.75 ... (7a)
1.8<(D1 T-D1W)/(D2 W-D2T) <2.5 ... (8a)
0.25 <Rb/f3B — < — 0.27 ... (10a)
Next, the numerical examples 1-5 respectively corresponding to the operation gestalten 1-5 of this invention are shown. In each numerical example, i shows the sequence of the optical surface from a body side, and spacing between the i-th page and the i+1st page, and ni and nui show the refractive index of the quality of the material of the i-th optical member [as opposed to / as opposed to / in ri / the radius of curvature of the i-th optical surface (the i-th page) / d line in di], and the Abbe number, respectively. f is [the f number and omega of a focal distance and FNO] half-field angles. moreover, k — eccentricity, and b, c, d and e — an aspheric surface configuration, when setting the variation rate of an aspheric surface multiplier and the direction of an optical axis in the location of height h from an optical axis to x for ... on the basis of a plane peak point It is displayed by 1+[1-(1+k) (h/R)2] 1 / x= (h2/R) / [2]+bh4+ch6+dh8+eh10. However, R is radius of curvature. The display of "e-Z [moreover,]" means "10-Z." Moreover, correspondence with the conditional expression in each numerical example mentioned above is shown in Table 1.
[0054] When spacing d=.0 has the radius of curvature of the lens side by the side of a body or the image surface, the refractive index of an ingredient, and the equal Abbe number in a numerical example, the dummy side on a mere design is shown, or the radius of curvature of the lens side by the side of a body or the image surface is equal, and when the refractive index of an ingredient differs from the Abbe number, it is shown that the lens side by the side of a body and the image surface is joined.

[0055] Moreover, in the numerical examples 1, 2, 4, and 5, gamma= 16 shows the fictitious field on a design. gamma= 20 of the numerical examples 1 and 2, gamma= 2 of the numerical example 5, and gamma= 20 are fictitious fields, and the field of order is a lamination side.

[0056]

[External Character 1]

数値実施例 1

f= 29.0～ 194.0 FNo=1: 3.6～ 5.8 2ω=73.5° ～12.7°

r 1=	145.396	d 1=	2.00	n 1=1.84666	v 1=23.9
r 2=	62.461	d 2=	0.50		
r 3=	60.486	d 3=	8.28	n 2=1.62299	v 2=58.2
r 4=	-397.703	d 4=	0.12		
r 5=	50.318	d 5=	4.59	n 3=1.72916	v 3=54.7
r 6=	108.499	d 6=	可変		
r 7=	178.597	d 7=	1.20	n 4=1.77250	v 4=49.6
r 8=	15.964	d 8=	6.11		
r 9=	-43.315	d 9=	1.10	n 5=1.80400	v 5=46.6
r10=	46.961	d10=	0.10		
r11=	30.482	d11=	4.75	n 6=1.84666	v 6=23.9
r12=	-43.259	d12=	0.65		
r13=	-32.013	d13=	1.10	n 7=1.80400	v 7=46.6
r14=	555.389	d14=	可変		
r15=	(絞り)	d15=	1.50		
r16=	46.334	d16=	3.09	n 8=1.58313	v 8=59.4
r17=	-71.004	d17=	0.12		
r18=	27.732	d18=	4.87	n 9=1.62299	v 9=58.2
r19=	-24.911	d19=	1.15	n10=1.80518	v10=25.4
r20=	852.335	d20=	可変		
r21=	-156.621(非球面)	d21=	4.05	n11=1.78472	v11=25.7
r22=	-18.808	d22=	1.10	n12=1.83400	v12=37.2
r23=	77.280	d23=	可変		
r24=	65.449(非球面)	d24=	4.88	n13=1.58313	v13=59.4
r25=	-27.619	d25=	0.09		
r26=	-120.511	d26=	3.72	n14=1.51633	v14=64.1
r27=	-38.003	d27=	0.08		
r28=	194.443	d28=	5.54	n15=1.51742	v15=52.4
r29=	-22.071	d29=	1.50	n16=1.83481	v16=42.7
r30=	53.240	d30=	可変		
r31=	フレアー絞り				

焦点距離 / 可変間隔	28.98	63.35	194.00
d 6	2.16	19.93	42.47
d 14	21.61	12.31	0.59
d 20	2.00	2.00	2.00
d 23	7.57	3.90	1.44
d 30	2.00	19.70	33.84
skinf	39.04	39.04	39.04

非球面係数

	b	c	d
第21面	4.596840e-06	1.428318e-09	5.693594e-12
第24面	-2.636888e-05	2.868176e-10	2.017636e-11

[0057]

[External Character 2]

数値実施例 2

f= 29.1～ 193.4 FNo=1: 3.6～ 5.9 2ω=73.2° ～12.8°

r 1=	172.364	d 1=	2.00	n 1=1.84666	v 1=23.9
r 2=	65.212	d 2=	0.17		
r 3=	64.137	d 3=	7.78	n 2=1.62299	v 2=58.2
r 4=	-308.235	d 4=	0.12		
r 5=	49.294	d 5=	5.18	n 3=1.72916	v 3=54.7
r 6=	124.744	d 6=	可変		
r 7=	225.181	d 7=	1.20	n 4=1.77250	v 4=49.6
r 8=	15.505	d 8=	5.52		
r 9=	-39.903	d 9=	1.10	n 5=1.80400	v 5=46.6
r10=	49.650	d10=	0.10		
r11=	28.824	d11=	4.98	n 6=1.84666	v 6=23.9
r12=	-39.551	d12=	0.99		
r13=	-28.247	d13=	1.10	n 7=1.80400	v 7=46.6
r14=	149.205	d14=	可変		
r15=	(絞り)	d15=	1.50		
r16=	48.977	d16=	2.99	n 8=1.58313	v 8=59.4
r17=	-52.793	d17=	0.12		
r18=	27.914	d18=	4.76	n 9=1.62299	v 9=58.2
r19=	-22.260	d19=	1.15	n10=1.80518	v10=25.4
r20=	-874.109	d20=	可変		
r21=	-140.649(非球面)	d21=	3.61	n11=1.78472	v11=25.7
r22=	-18.354	d22=	1.10	n12=1.83400	v12=37.2
r23=	88.395	d23=	可変		
r24=	61.971(非球面)	d24=	5.82	n13=1.58313	v13=59.4
r25=	-28.721	d25=	0.10		
r26=	-148.759	d26=	2.87	n14=1.51633	v14=64.1
r27=	-35.209	d27=	0.10		
r28=	117.864	d28=	5.21	n15=1.51742	v15=52.4
r29=	-22.011	d29=	1.50	n16=1.83481	v16=42.7
r30=	45.460	d30=	可変		
r31=	フレアー絞り				

焦点距離 / 可変間隔	29.14	65.94	193.44
d 6	2.59	20.34	39.86
d 14	16.77	9.24	0.42
d 20	2.00	2.00	2.00
d 23	7.83	3.85	1.09
d 30	2.00	20.76	37.82
skinf	39.04	39.04	39.04

非球面係数

第 21 面	b	c	d
	4.010865e-06	1.009779e-08	-4.008974e-11
第 24 面	b	c	d
	-2.636888e-05	2.868176e-10	2.017636e-11

[0058]

[External Character 3]

数値実施例3
f= 29.0～194.7 FNo=1:3.4～5.9 2ω=73.5°～12.7°

r 1=	119.141	d 1=	2.00	n 1=1.80518	v 1=25.4
r 2=	47.258	d 2=	6.60	n 2=1.65844	v 2=50.9
r 3=	431.430	d 3=	0.10		
r 4=	55.237	d 4=	4.91	n 3=1.73400	v 3=51.5
r 5=	283.475	d 5=	可変		
r 6=	245.879(非球面)	d 6=	1.50	n 4=1.83481	v 4=42.7
r 7=	17.471	d 7=	5.29		
r 8=	-46.390	d 8=	1.20	n 5=1.79500	v 5=45.3
r 9=	59.109	d 9=	0.10		
r10=	30.218	d10=	5.77	n 6=1.74077	v 6=27.8
r11=	-28.878	d11=	0.79		
r12=	-22.026	d12=	1.20	n 7=1.79500	v 7=45.3
r13=	47.810	d13=	2.50	n 8=1.84666	v 8=23.9
r14=	456.731	d14=	可変		
r15=	絞り	d15=	0.00		
r16=	30.567	d16=	4.24	n 9=1.64250	v 9=58.4
r17=	-49.182	d17=	0.10		
r18=	30.576(絞り)	d18=	3.33	n10=1.65830	v10=57.3
r19=	-106.685	d19=	0.88		
r20=	-40.168	d20=	1.20	n11=1.84666	v11=23.9
r21=	110.896	d21=	可変		
r22=	-112.171(非球面)	d22=	2.40	n12=1.67270	v12=32.1
r23=	-29.482	d23=	1.00	n13=1.75500	v13=52.3
r24=	94.808	d24=	可変		
r25=	32.251(非球面)	d25=	4.09	n14=1.51633	v14=64.1
r26=	-31.058	d26=	0.03		
r27=	102.951	d27=	1.50	n15=1.80100	v15=35.0
r28=	26.242	d28=	1.13		
r29=	77.006	d29=	2.74	n16=1.66755	v16=41.9
r30=	-58.919	d30=	0.10		
r31=	73.058	d31=	5.28	n17=1.57501	v17=41.5
r32=	-17.221	d32=	1.20	n18=1.78590	v18=44.2
r33=	59.754	d33=	可変		
r34=	フレアー絞り				

焦点距離 / 可変間隔	28.97	71.04	194.66
d 5	1.72	19.32	37.66
d 14	21.05	11.39	2.33
d 21	2.00	2.00	2.00
d 24	6.26	2.36	0.69
d 33	-0.04	22.92	42.32
skinf	38.89	38.89	38.89

非球面係数

	a	b	c	d	e
第6面	1.399782e-08	1.908188e-06	7.504791e-09	-1.503685e-11	8.287331e-14

	b	c	d
第22面	3.808724e-06	6.747410e-09	5.413100e-11
第25面	-2.638325e-05	7.880542e-09	-8.642631e-11

[0059]
[External Character 4]

数値実施例4

f= 29.0～ 194.2 FNo=1: 3.6～ 5.4 2ω=73.4°～12.7°

r 1=	158.058	d 1=	2.00	n 1=1.84666	v 1=23.9
r 2=	64.867	d 2=	0.18		
r 3=	62.961	d 3=	7.93	n 2=1.62299	v 2=58.2
r 4=	-423.290	d 4=	0.12		
r 5=	50.927	d 5=	4.74	n 3=1.72916	v 3=54.7
r 6=	118.105	d 6=	可変		
r 7=	148.988	d 7=	1.20	n 4=1.77250	v 4=49.6
r 8=	16.033	d 8=	6.04		
r 9=	-47.419	d 9=	1.10	n 5=1.80400	v 5=46.6
r10=	48.990	d10=	0.10		
r11=	30.068	d11=	5.03	n 6=1.84666	v 6=23.9
r12=	-51.796	d12=	1.09		
r13=	-32.157	d13=	1.10	n 7=1.80400	v 7=46.6
r14=	484.280	d14=	可変		
r15=	(絞り)	d15=	1.50		
r16=	34.546	d16=	3.39	n 8=1.58313	v 8=59.4
r17=	-75.644	d17=	0.12		
r18=	34.509	d18=	5.64	n 9=1.62299	v 9=58.2
r19=	-37.900	d19=	0.40		
r20=	-24.674	d20=	1.15	n10=1.80518	v10=25.4
r21=	-474.712	d21=	可変		
r22=	-46.434	d22=	2.42	n11=1.80518	v11=25.4
r23=	-21.849	d23=	0.10		
r24=	-24.023	d24=	1.10	n12=1.83481	v12=42.7
r25=	184.480	d25=	可変		
r26=	78.975(非球面)	d26=	3.72	n13=1.58313	v13=59.4
r27=	-27.468	d27=	0.09		
r28=	-253.244	d28=	2.56	n14=1.51633	v14=64.1
r29=	-40.601	d29=	0.08		
r30=	130.541	d30=	4.22	n15=1.51742	v15=52.4
r31=	-33.434	d31=	1.50	n16=1.83481	v16=42.7
r32=	45.332	d32=	可変		
r33=	フレアー絞り				

焦点距離 / 可変間隔	29.01	62.49	194.22
d 6	2.11	20.01	42.95
d 14	21.41	12.34	0.51
d 21	2.50	2.50	2.50
d 25	7.33	3.73	1.25
d 32	2.00	19.27	33.12
skinf	42.64	42.64	42.64

非球面係数

第26面	b	c	d
	-2.636888e-05	2.868176e-10	2.017636e-11

[0060]

[External Character 5]

数値実施例5
f= 29.0～ 193.6 FNo=1: 3.6～ 5.8 2ω=73.4° ～12.8°
r 1= 169.733 d 1= 2.00 n 1=1.84666 v 1=23.9
r 2= 67.818 d 2= 7.55 n 2=1.62299 v 2=58.2
r 3= -551.360 d 3= 0.12
r 4= 52.665 d 4= 5.41 n 3=1.72916 v 3=54.7
r 5= 156.381 d 5= 可変
r 6= 127.659 d 6= 1.20 n 4=1.77250 v 4=49.6
r 7= 16.045 d 7= 6.37
r 8= -42.636 d 8= 1.10 n 5=1.80400 v 5=46.6
r 9= 68.672 d 9= 0.10
r10= 31.049 d10= 4.69 n 6=1.84666 v 6=23.9
r11= -46.059 d11= 0.75
r12= -33.038 d12= 1.10 n 7=1.80400 v 7=46.6
r13= 112.487 d13= 可変
r14= (絞り) d14= 1.50
r15= 37.074 d15= 3.14 n 8=1.60562 v 8=43.7
r16= -62.010 d16= 0.12
r17= 32.202 d17= 5.15 n 9=1.62299 v 9=58.2
r18= -23.452 d18= 1.15 n10=1.84666 v10=23.9
r19= 515.977 d19= 可変
r20= -53.586 d20= 3.73 n11=1.83400 v11=37.2
r21= -13.978 d21= 1.10 n12=1.77250 v12=49.6
r22= 100.085 d22= 可変
r23= 75.579(非球面) d23= 3.32 n13=1.58313 v13=59.4
r24= -31.818 d24= 0.09
r25= 558.699 d25= 3.00 n14=1.51633 v14=64.1
r26= -39.182 d26= 0.08
r27= 395.261 d27= 3.43 n15=1.51742 v15=52.4
r28= -54.407 d28= 1.50 n16=1.83481 v16=42.7
r29= 43.276 d29= 可変
r30= フレアー絞り

焦点距離 / 可変間隔	29.00	63.20	193.58
d 5	2.04	20.04	42.30
d 13	21.03	11.87	0.31
d 19	2.00	2.00	2.00
d 22	7.65	3.72	1.05
d 29	2.00	19.58	34.05
skinf	44.33	44.33	44.33

非球面係数
第23面 b c d
-2.626888e-05 2.868176e-10 2.017636e-11

[0061]
[Table 1]

	条件式	下限値	上限値	実施例1	実施例2	実施例3	実施例4	実施例5
4	|f2/fT|	0.04	0.1	0.081	0.071	0.078	0.080	0.080
5	|f3b/f3a|	1.5	2.5	1.91	2.14	2.16	1.79	1.85
6	f4/fT	0.2	0.4	0.29	0.28	0.30	0.26	0.26
7	LW/fT	0.5	0.8	0.70	0.68	0.68	0.70	0.71
8	(D1T-D1W)/(D2W-D2T)	1.5	3	1.92	2.28	1.92	1.98	1.94
9	f3b	0	-	3.8	2.3	1.8	0.9	1.1
10	Rb/f3b	0.22	0.29	0.35	0.33	0.50	—	0.27

[0062] Next, the operation gestalt of the single-lens reflex camera system using the zoom lens of this invention is explained using drawing 36 . In drawing 36 , record means, such as a film which records the interchangeable lens carrying the zoom lens according [11] to this invention and the photographic subject image with which 12 is obtained through an interchangeable lens 11 according [10] to the body of a single-lens reflex camera, and an image sensor, the finder optical system to which 13 observes the photographic subject image from an interchangeable lens 11, and 14 are quick return mirrors rotated for changing and transmitting the photographic subject image from an interchangeable lens 11 to the record means 12 and the finder optical system 13. When observing a photographic subject image by the finder, after using as an erect image the photographic subject image which carried out image formation to the focus plate 15

through the quick return mirror 14 by the pentaprism 16, it expands and observes by the eyepiece optical system 17. At the time of photography, the quick return mirror 14 rotates in the direction of an arrow head, image formation of the photographic subject image is carried out to the record means 12, and it is recorded on it.

[0063] Thus, by applying the zoom lens of this invention to optical instruments, such as a single-lens reflex camera interchangeable lens, an optical instrument with high optical-character ability is realizable.

[0064] In addition, this invention is applicable also like an SLR (Single lens Reflex) camera without a quick return mirror.

[0065]

[Effect of the Invention] Movement magnitude of the amendment optical system for performing miniaturization of amendment optical system and the image blurring amendment effectiveness of a constant rate can be controlled easily, maintaining high definition by arranging amendment optical system for image blurring amendment appropriately according to this invention, and the optical instrument which has the zoom lens and it which can perform the electric drive of amendment optical system easily can be attained.

[0066] According to this invention, in addition, the 1st lens group of refractive power more nearly forward than a body side, the 2nd lens group of negative refractive power, It constitutes from a 3b lens group. the 3rd lens group of forward refractive power, and the 4th lens group of forward refractive power — constituting — the 3rd lens group L3 — the [of forward refractive power] — the [of 3a lens group and negative refractive power] — the [said] — 3b lens group is moved so that it may have an optical axis and a vertical component, vibrationproofing is performed, by giving suitable refractive-power arrangement and a lens configuration, a looking-far region can be covered from a wide angle region, and the optical instrument which has the zoom lens of high variable power of compact and good optical-character ability and it can be attained.

[Translation done.]

* NOTICES *

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damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The lens sectional view of the wide angle edge of the operation gestalt 1 of this invention
[Drawing 2] The longitudinal aberration Fig. in the wide angle edge of the normal state of the operation gestalt 1 of this invention
[Drawing 3] The longitudinal aberration Fig. in the tele edge of the normal state of the operation gestalt 1 of this invention
[Drawing 4] The transverse aberration Fig. in the wide angle edge of the normal state of the operation gestalt 1 of this invention
[Drawing 5] The transverse aberration Fig. in the tele edge of the normal state of the operation gestalt 1 of this invention
[Drawing 6] The transverse aberration Fig. in the wide angle edge of amendment of image blurring for the field angle of 0.3 degrees of the operation gestalt 1 of this invention
[Drawing 7] The transverse aberration Fig. in the tele edge of amendment of image blurring for the field angle of 0.3 degrees of the operation gestalt 1 of this invention
[Drawing 8] The lens sectional view of the wide angle edge of the operation gestalt 2 of this invention
[Drawing 9] The longitudinal aberration Fig. in the wide angle edge of the normal state of the operation gestalt 2 of this invention
[Drawing 10] The longitudinal aberration Fig. in the tele edge of the normal state of the operation gestalt 2 of this invention
[Drawing 11] The transverse aberration Fig. in the wide angle edge of the normal state of the operation gestalt 2 of this invention
[Drawing 12] The transverse aberration Fig. in the tele edge of the normal state of the operation gestalt 2 of this invention
[Drawing 13] The transverse aberration Fig. in the wide angle edge of amendment of image blurring for the field angle of 0.3 degrees of the operation gestalt 2 of this invention
[Drawing 14] The transverse aberration Fig. in the tele edge of amendment of image blurring for the field angle of 0.3 degrees of the operation gestalt 2 of this invention
[Drawing 15] The lens sectional view of the wide angle edge of the operation gestalt 3 of this invention
[Drawing 16] The longitudinal aberration Fig. in the wide angle edge of the normal state of the operation gestalt 3 of this invention
[Drawing 17] The longitudinal aberration Fig. in the tele edge of the normal state of the operation gestalt 3 of this invention
[Drawing 18] The transverse aberration Fig. in the wide angle edge of the normal state of the operation gestalt 3 of this invention
[Drawing 19] The transverse aberration Fig. in the tele edge of the normal state of the operation gestalt 3 of this invention
[Drawing 20] The transverse aberration Fig. in the wide angle edge of amendment of image blurring for the field angle of 0.3 degrees of the operation gestalt 3 of this invention

[Drawing 21] The transverse aberration Fig. in the tele edge of amendment of image blurring for the field angle of 0.3 degrees of the operation gestalt 3 of this invention
[Drawing 22] The lens sectional view of the wide angle edge of the operation gestalt 4 of this invention
[Drawing 23] The longitudinal aberration Fig. in the wide angle edge of the normal state of the operation gestalt 4 of this invention
[Drawing 24] The longitudinal aberration Fig. in the tele edge of the normal state of the operation gestalt 4 of this invention
[Drawing 25] The transverse aberration Fig. in the wide angle edge of the normal state of the operation gestalt 4 of this invention
[Drawing 26] The transverse aberration Fig. in the tele edge of the normal state of the operation gestalt 4 of this invention
[Drawing 27] The transverse aberration Fig. in the wide angle edge of amendment of image blurring for the field angle of 0.3 degrees of the operation gestalt 4 of this invention
[Drawing 28] The transverse aberration Fig. in the tele edge of amendment of image blurring for the field angle of 0.3 degrees of the operation gestalt 4 of this invention
[Drawing 29] The lens sectional view of the wide angle edge of the operation gestalt 5 of this invention
[Drawing 30] The longitudinal aberration Fig. in the wide angle edge of the normal state of the operation gestalt 5 of this invention
[Drawing 31] The longitudinal aberration Fig. in the tele edge of the normal state of the operation gestalt 5 of this invention
[Drawing 32] The transverse aberration Fig. in the wide angle edge of the normal state of the operation gestalt 5 of this invention
[Drawing 33] The transverse aberration Fig. in the tele edge of the normal state of the operation gestalt 5 of this invention
[Drawing 34] The transverse aberration Fig. in the wide angle edge of amendment of image blurring for the field angle of 0.3 degrees of the operation gestalt 5 of this invention
[Drawing 35] The transverse aberration Fig. in the tele edge of amendment of image blurring for the field angle of 0.3 degrees of the operation gestalt 5 of this invention
[Drawing 36] The important section schematic diagram of the optical instrument of this invention

[Description of Notations]
L1 The 1st group
L2 The 2nd group
L3 The 3rd group
L4 The 4th group
SP Aperture diaphragm
IP Image surface
d d line
g g line
S Sagittal image surface
M Meridional image surface
omega Field angle
fno F number
S.C Sine condition

[Translation done.]

* NOTICES *

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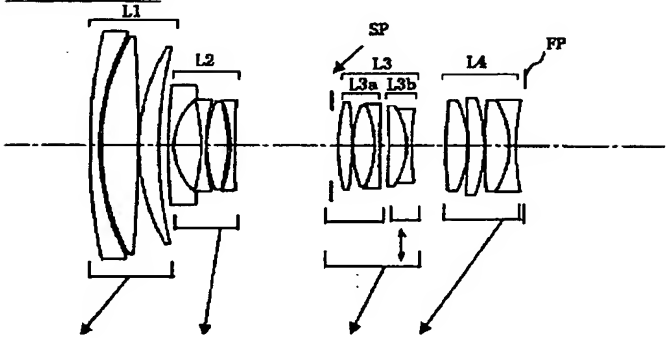
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



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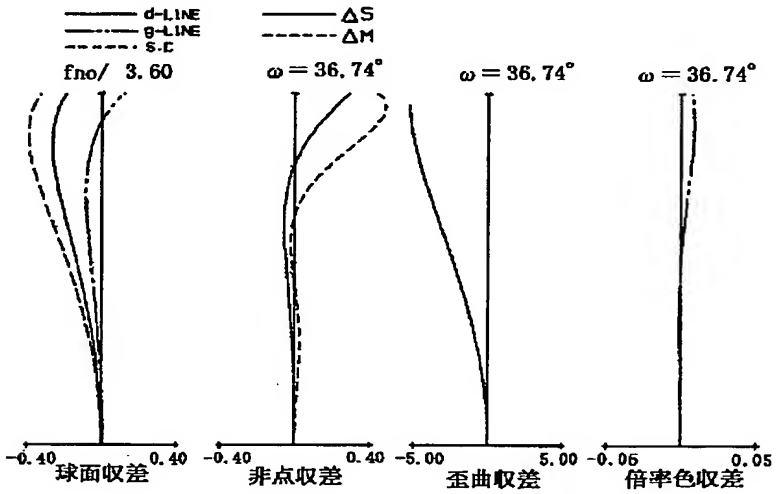

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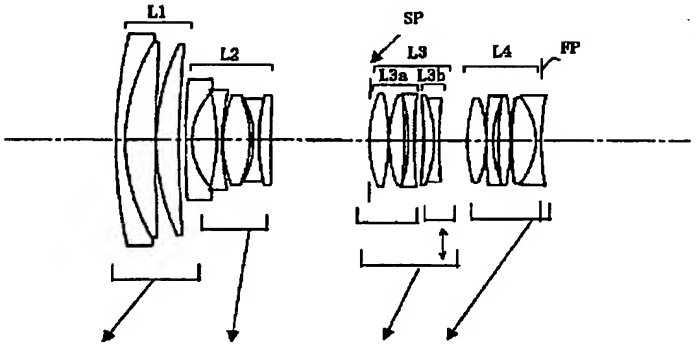

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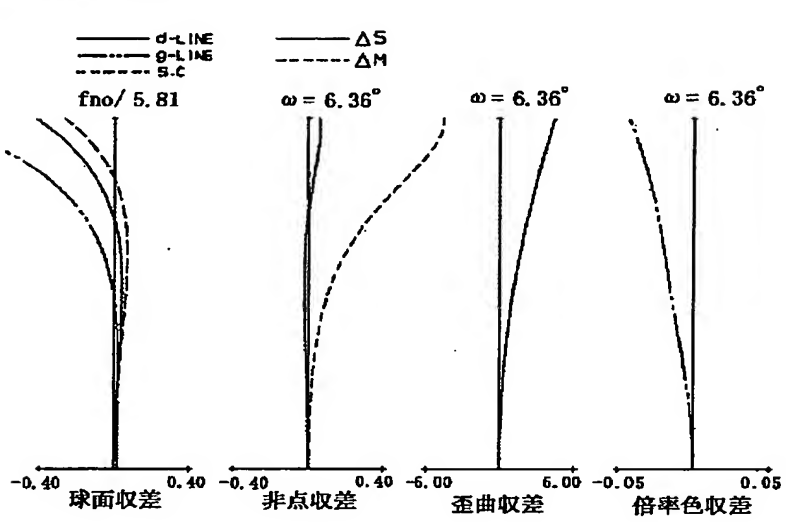

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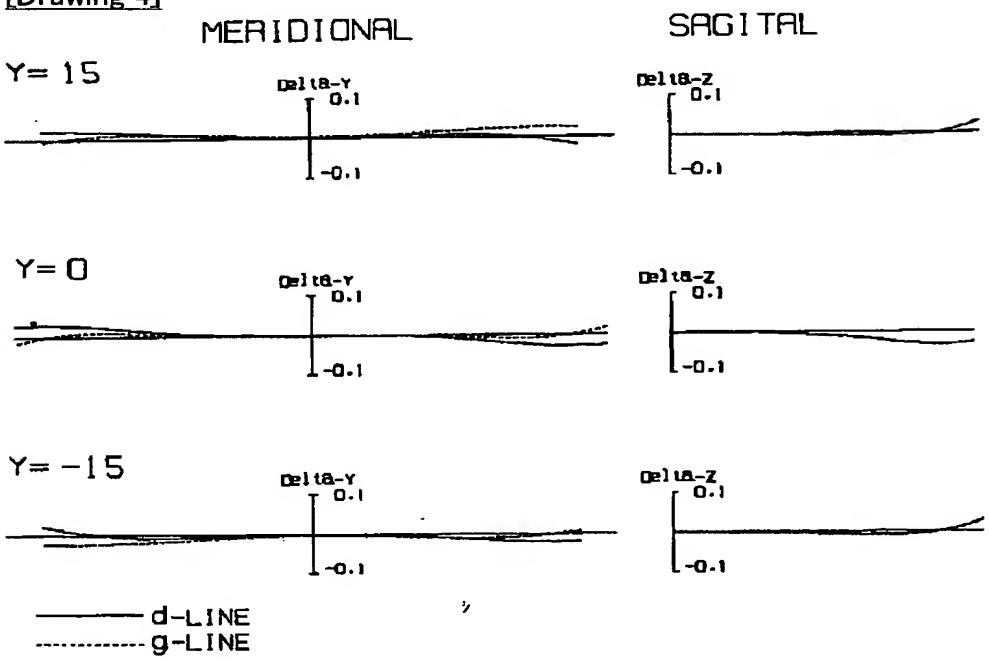

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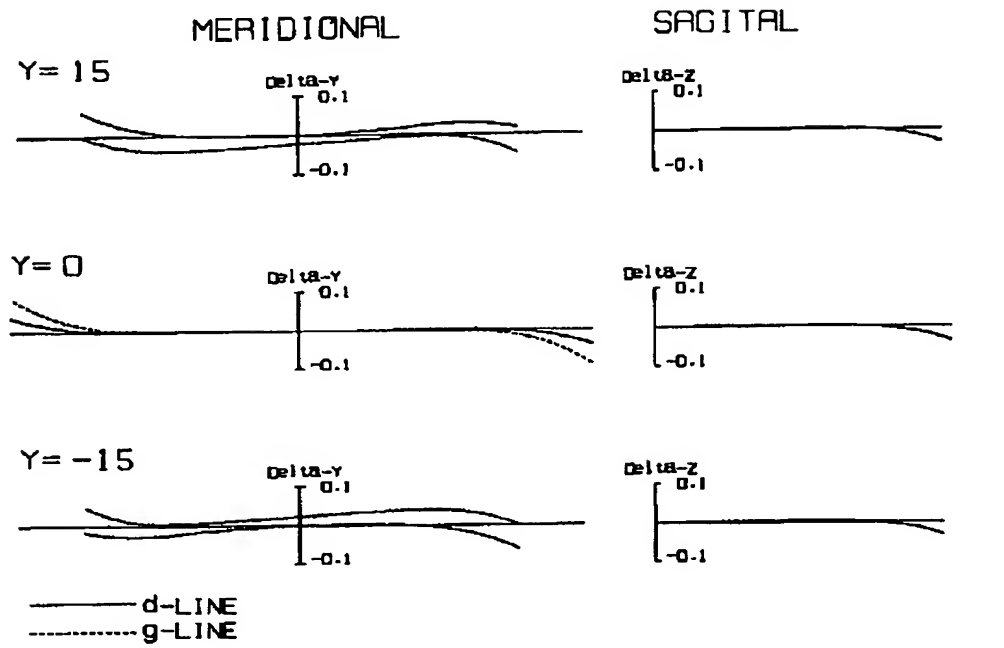

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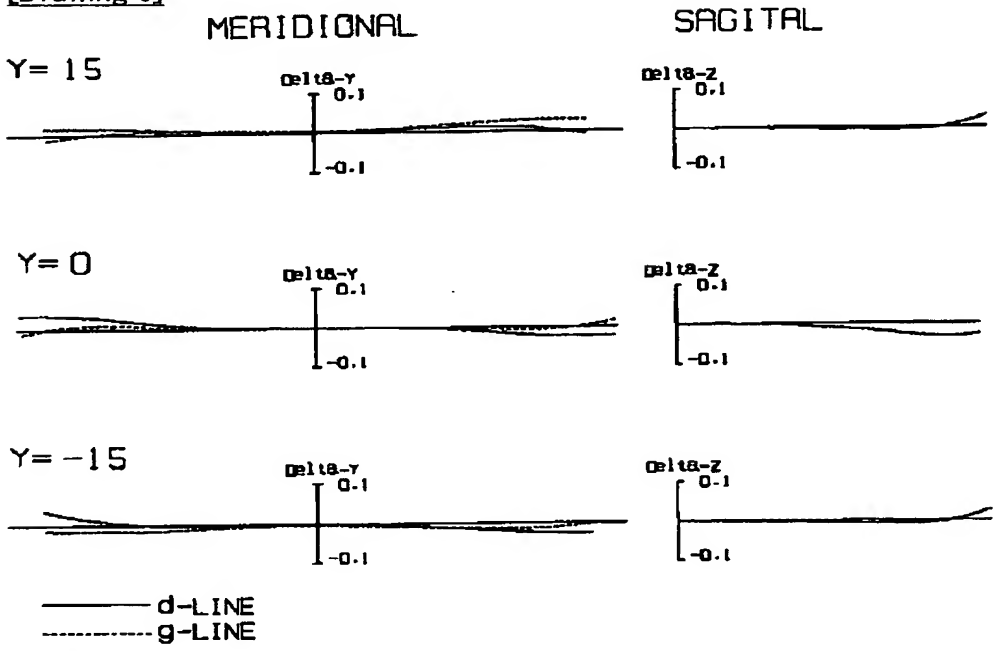

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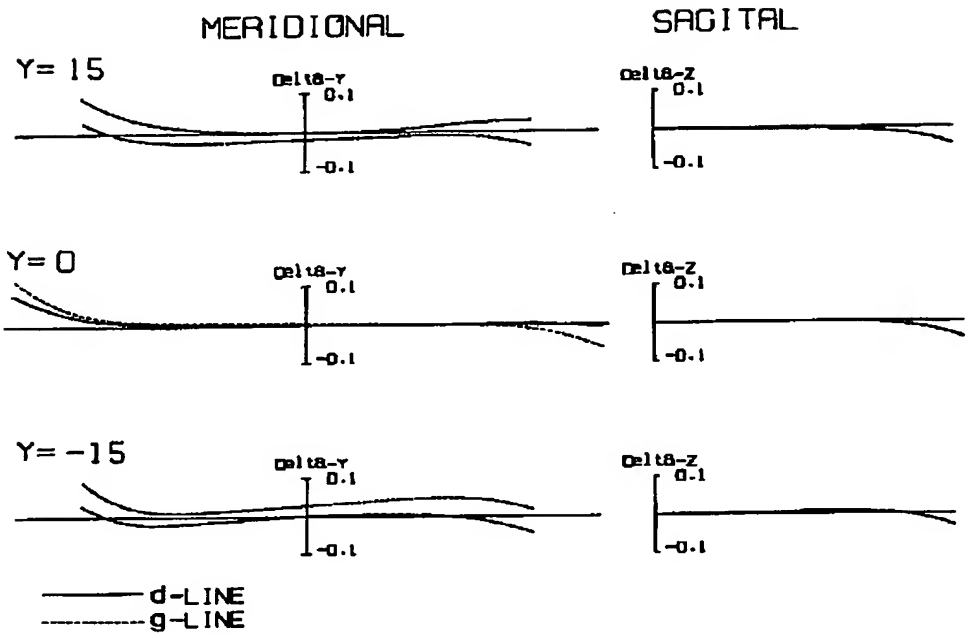

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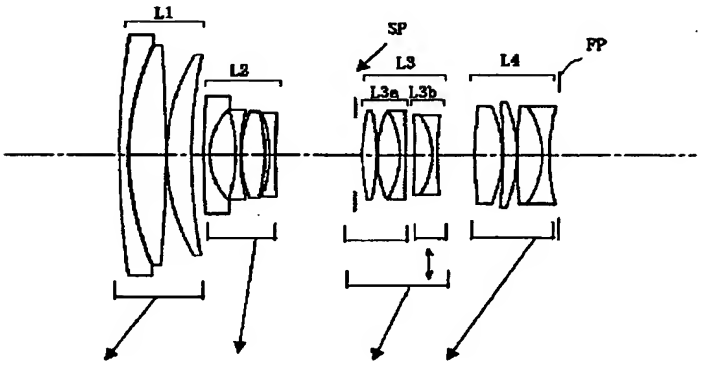

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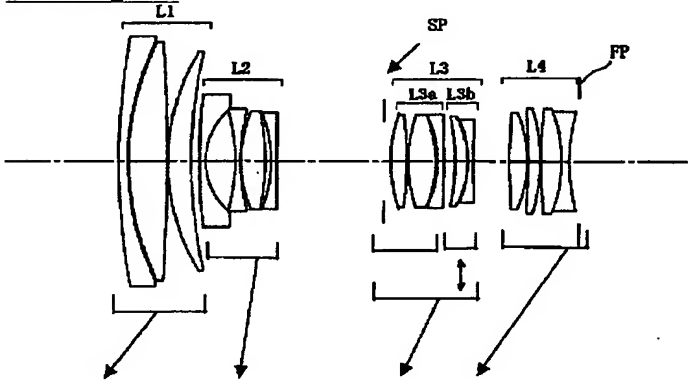

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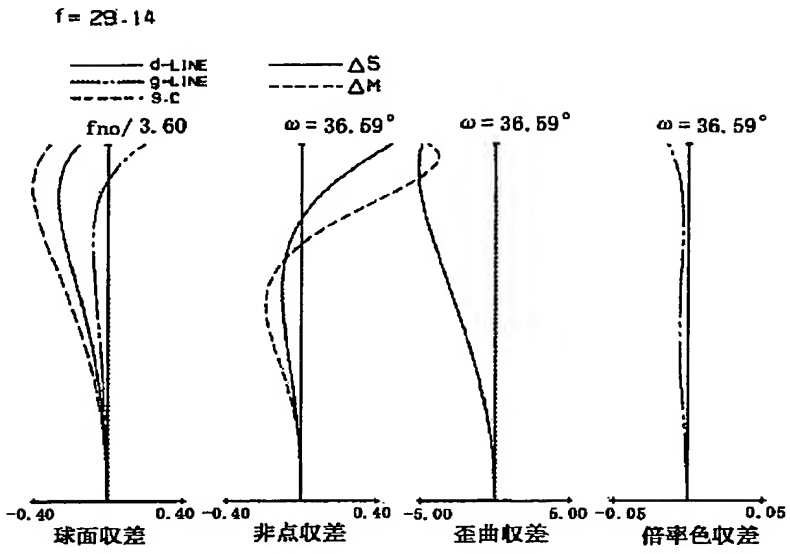

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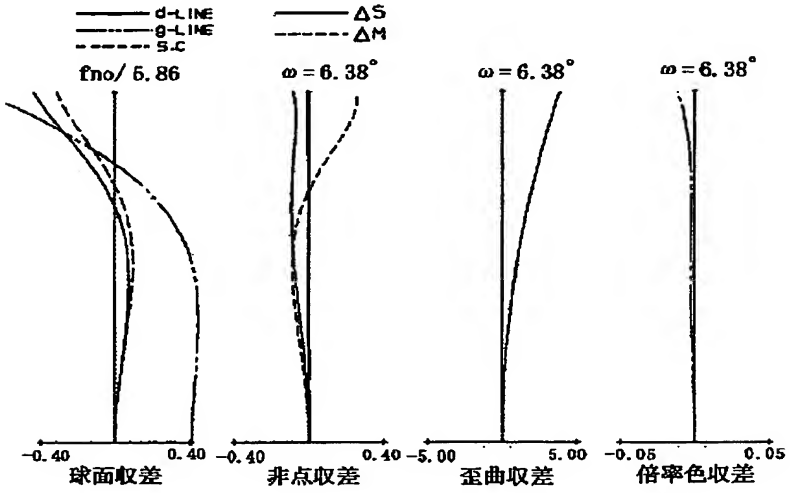

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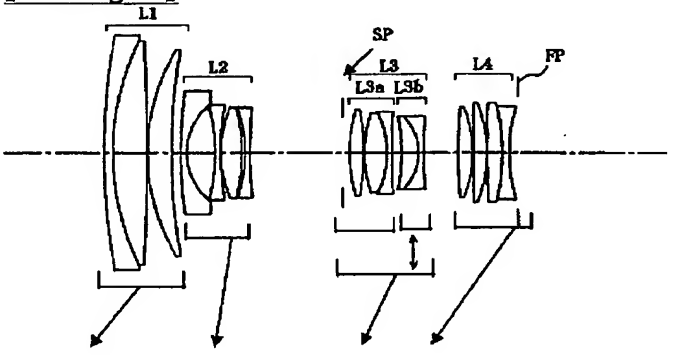

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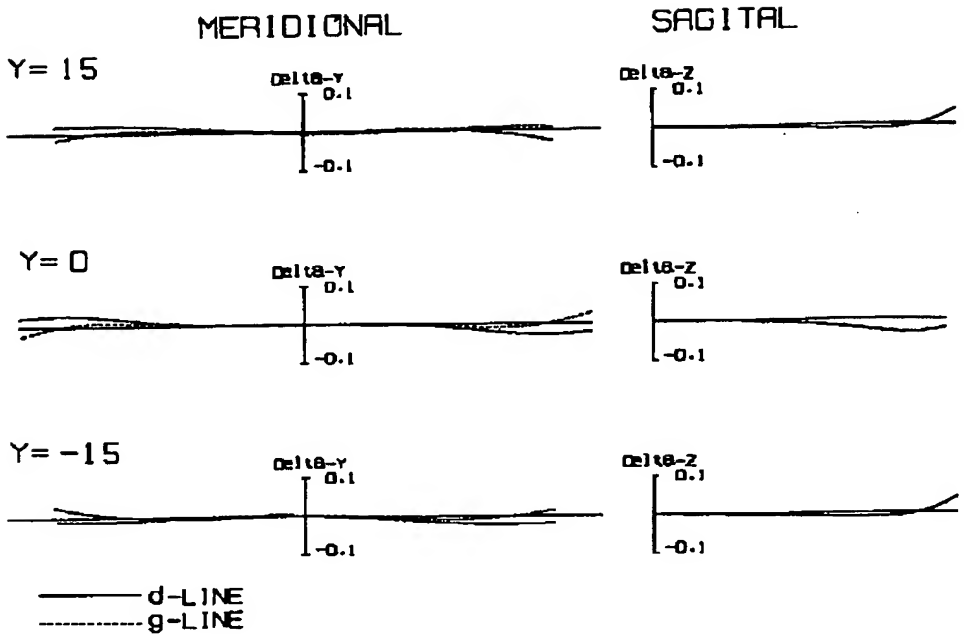

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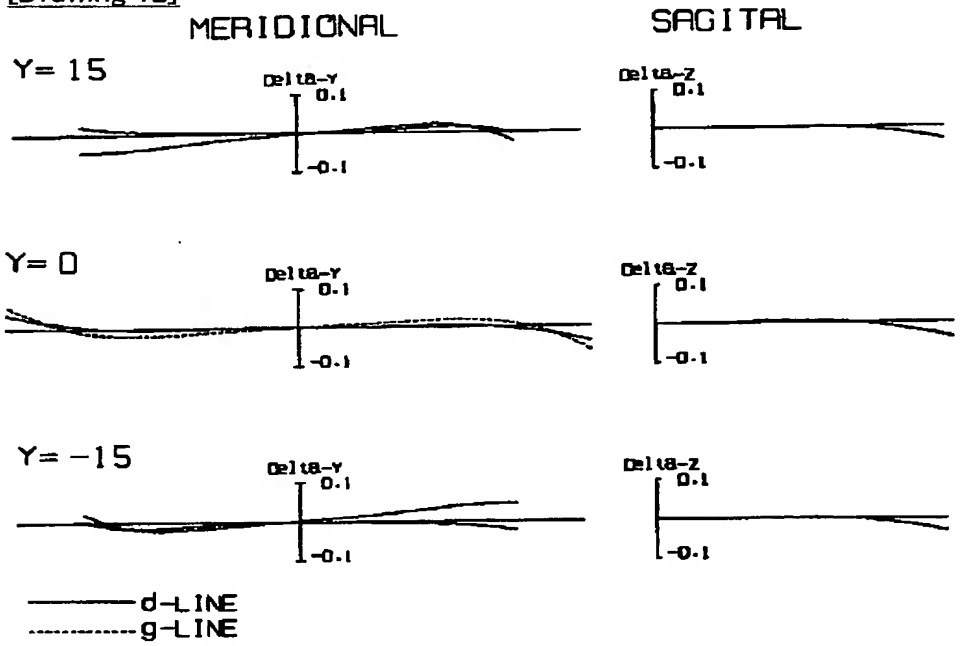

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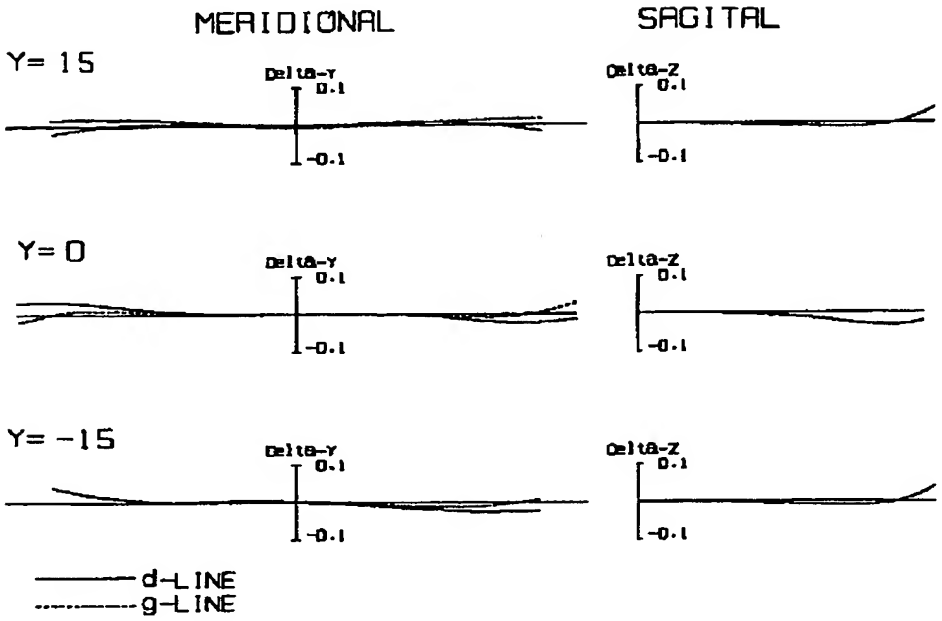

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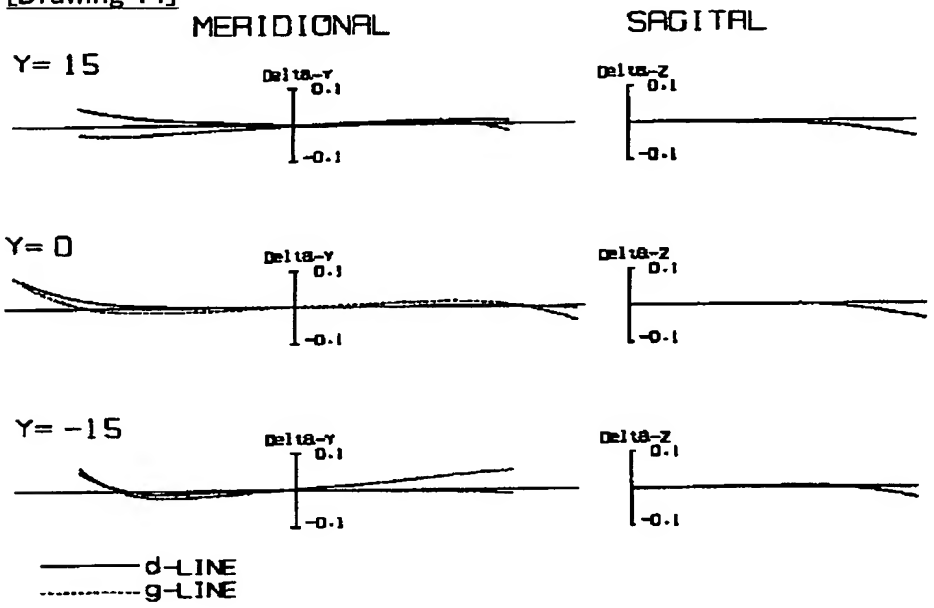

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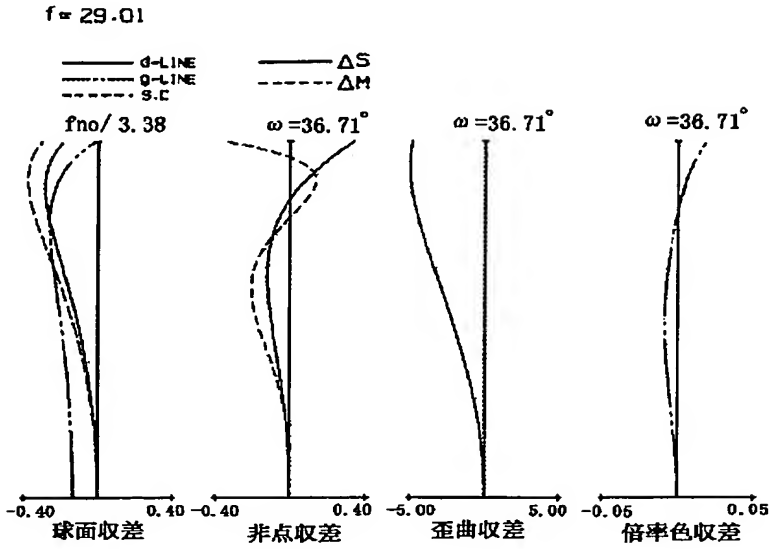

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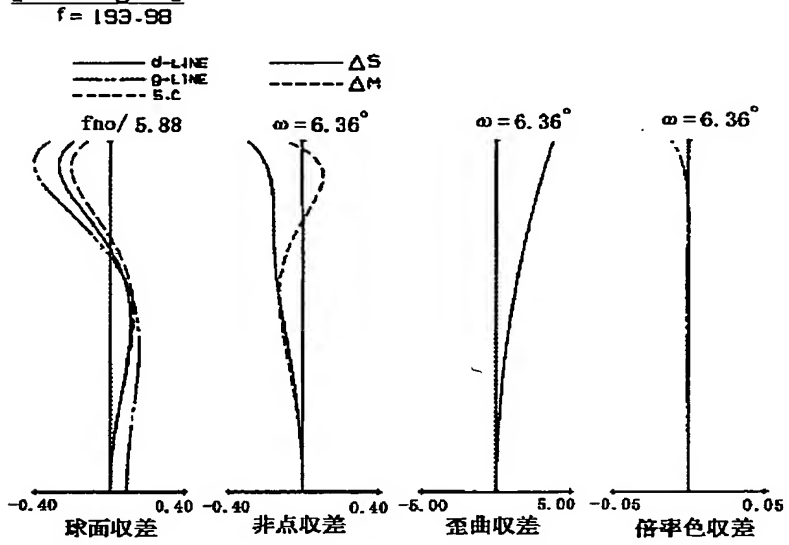
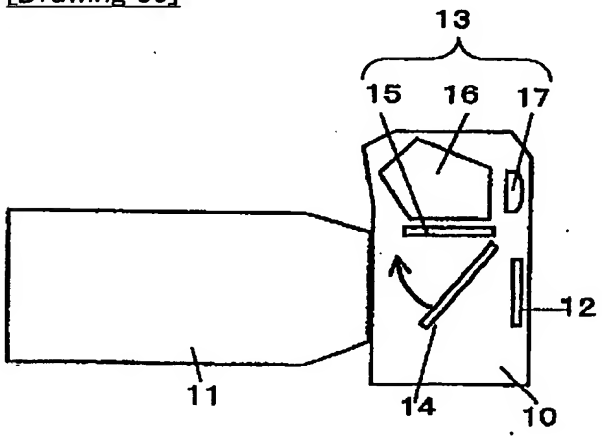


[Drawing 36]



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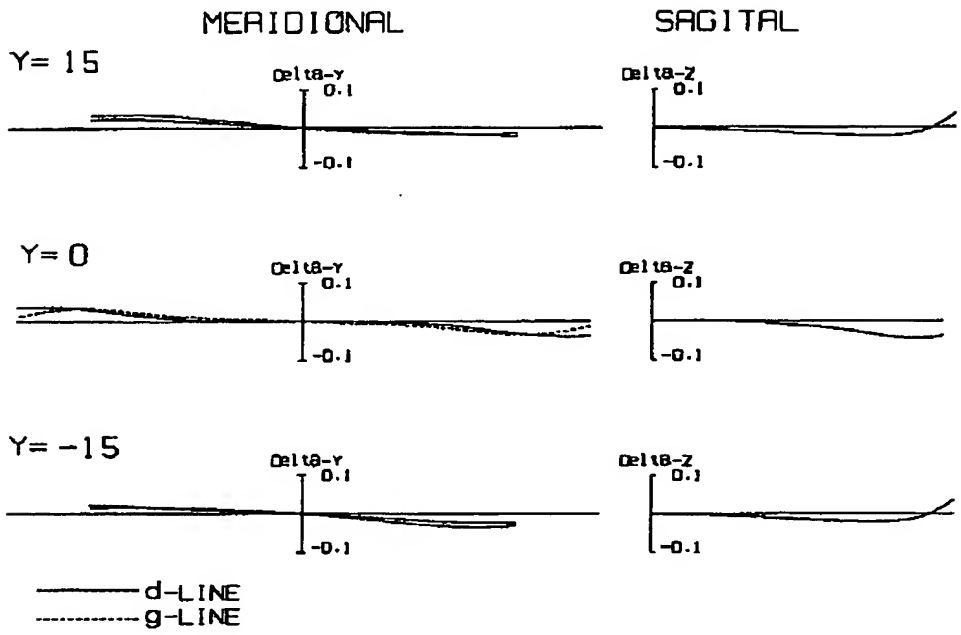

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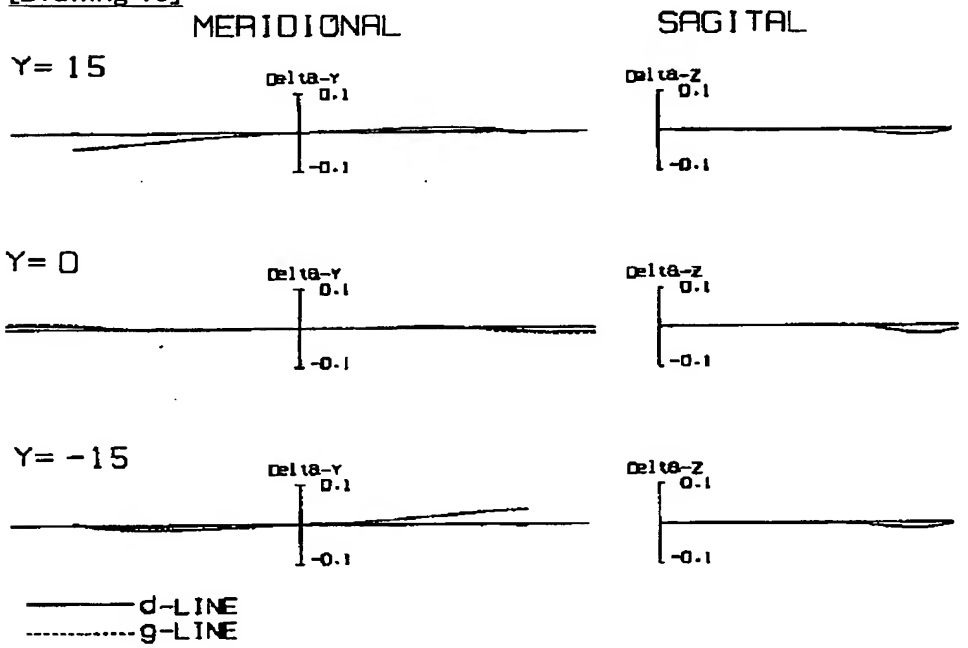

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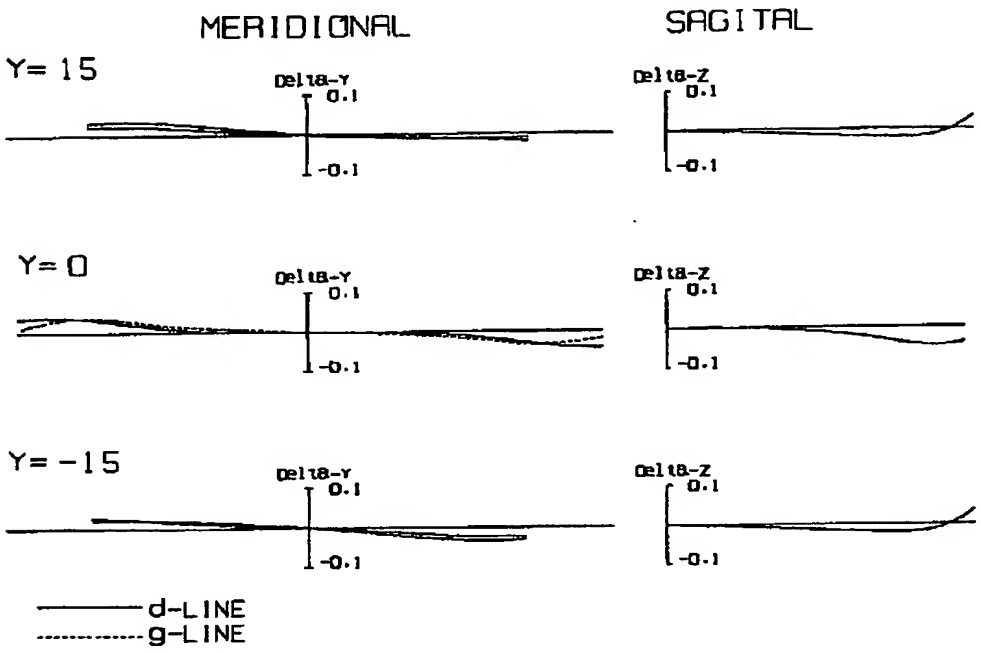
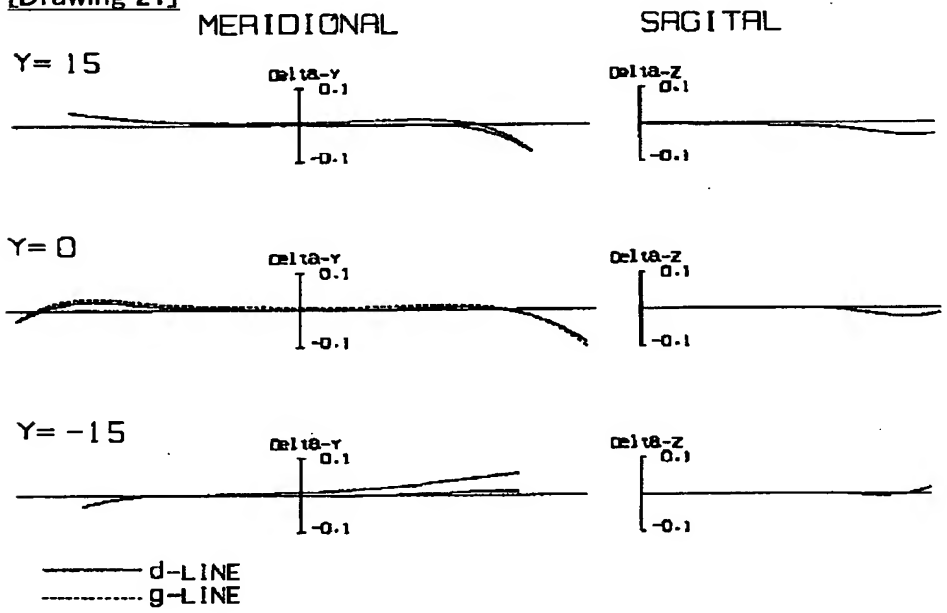


[Drawing 21]



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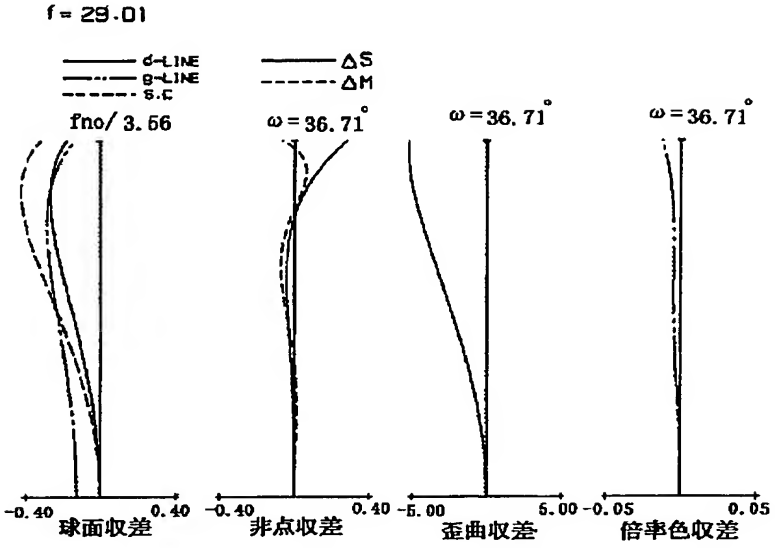

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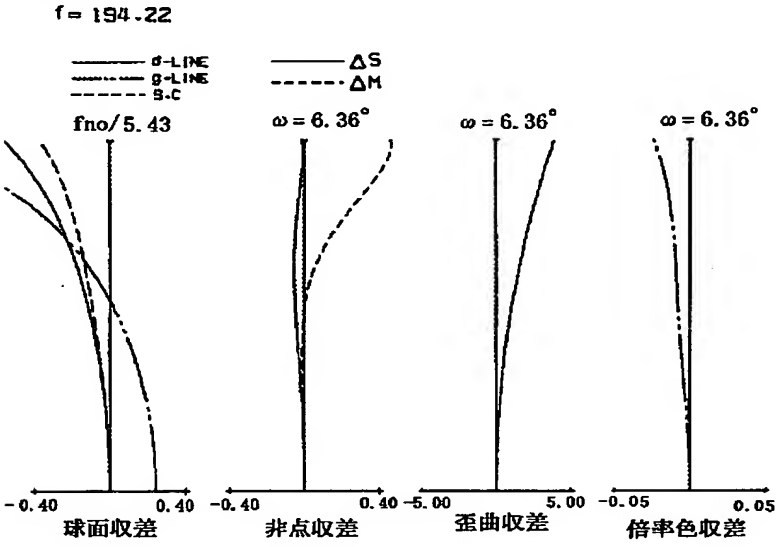

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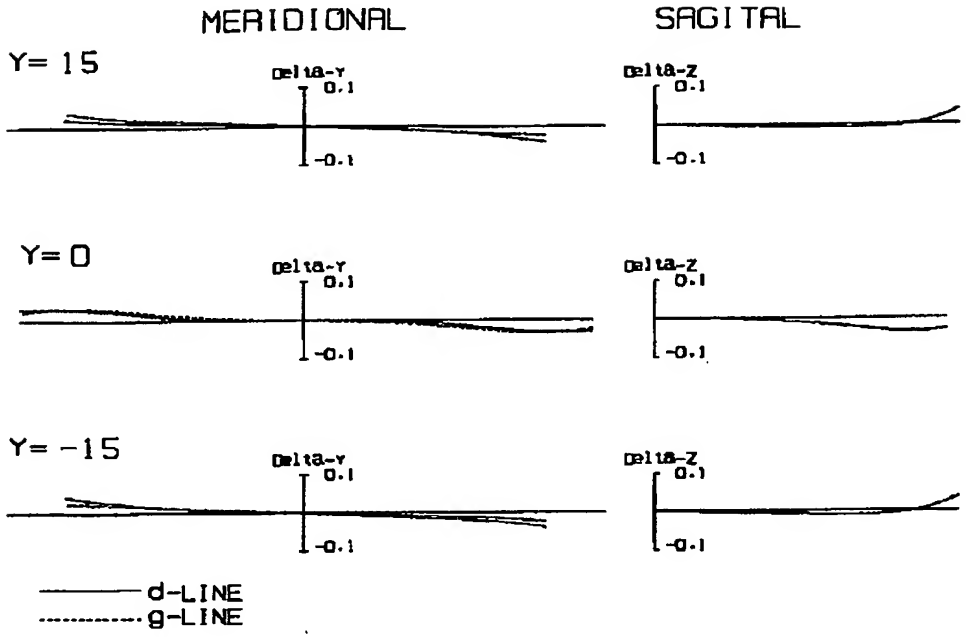

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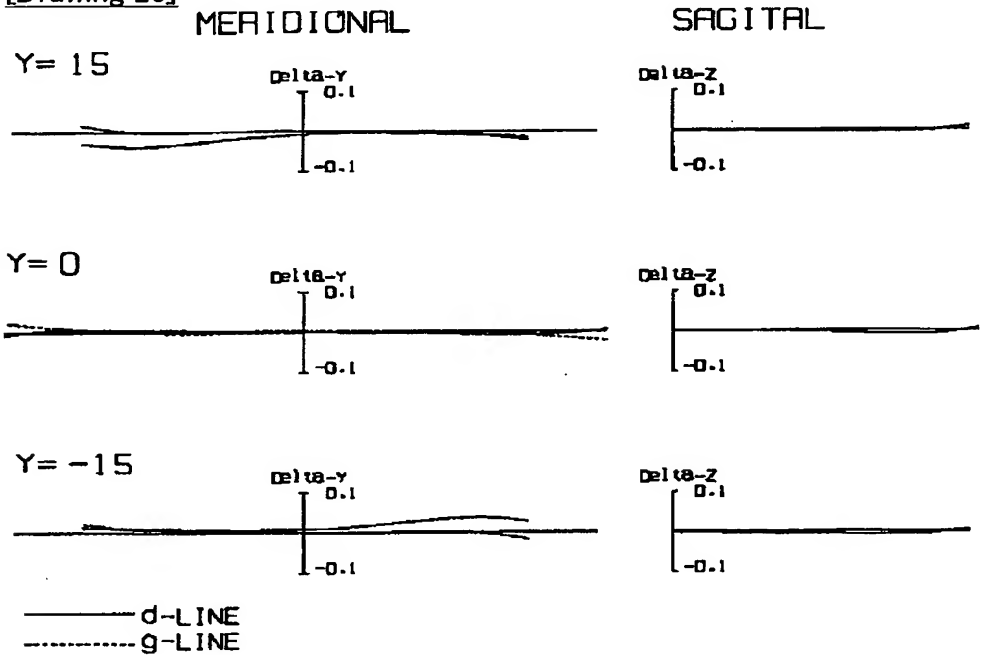

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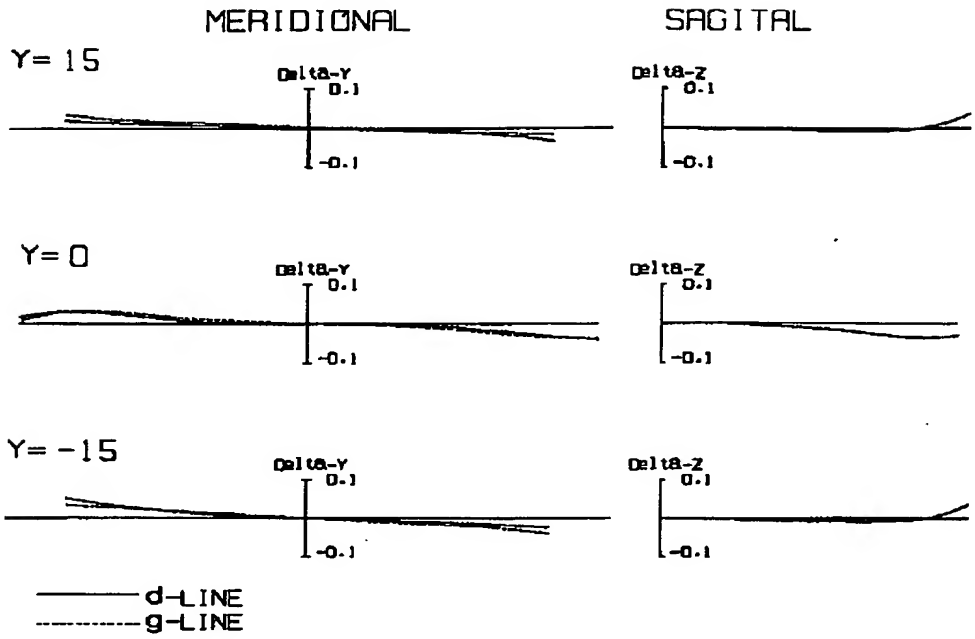

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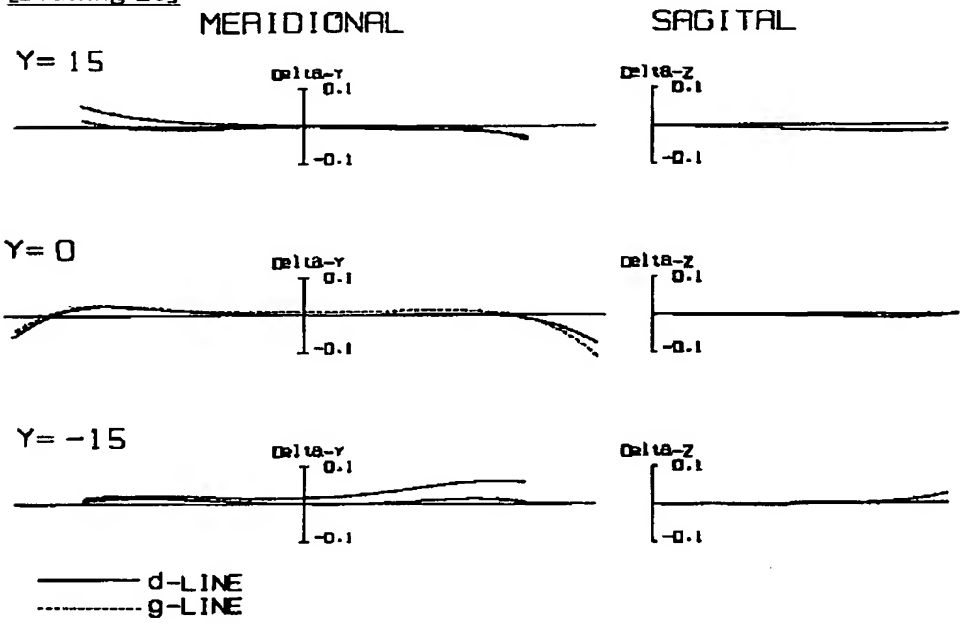

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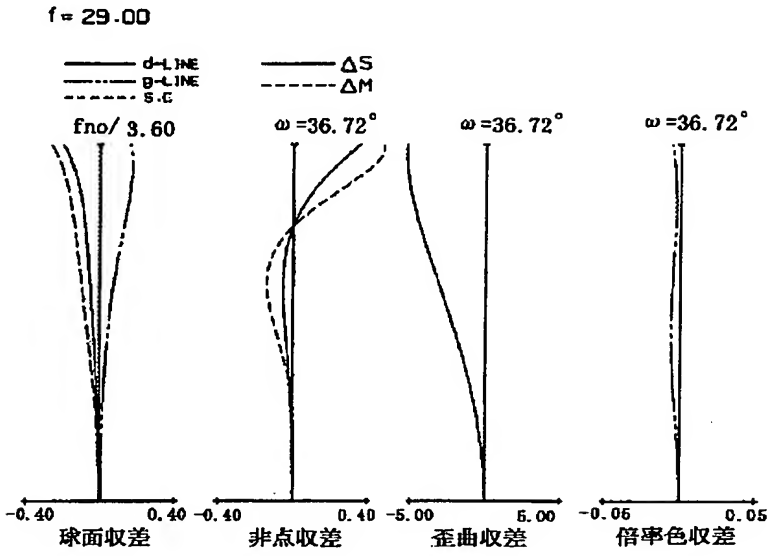

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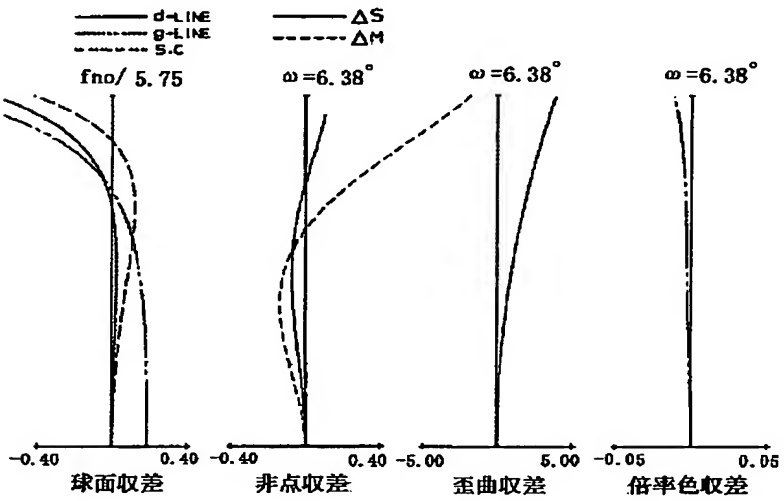

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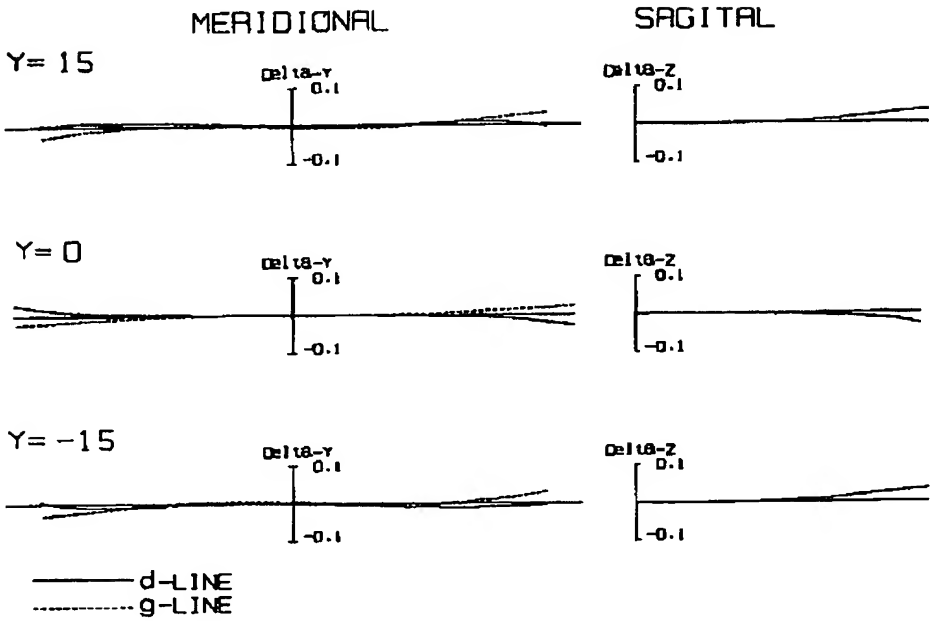

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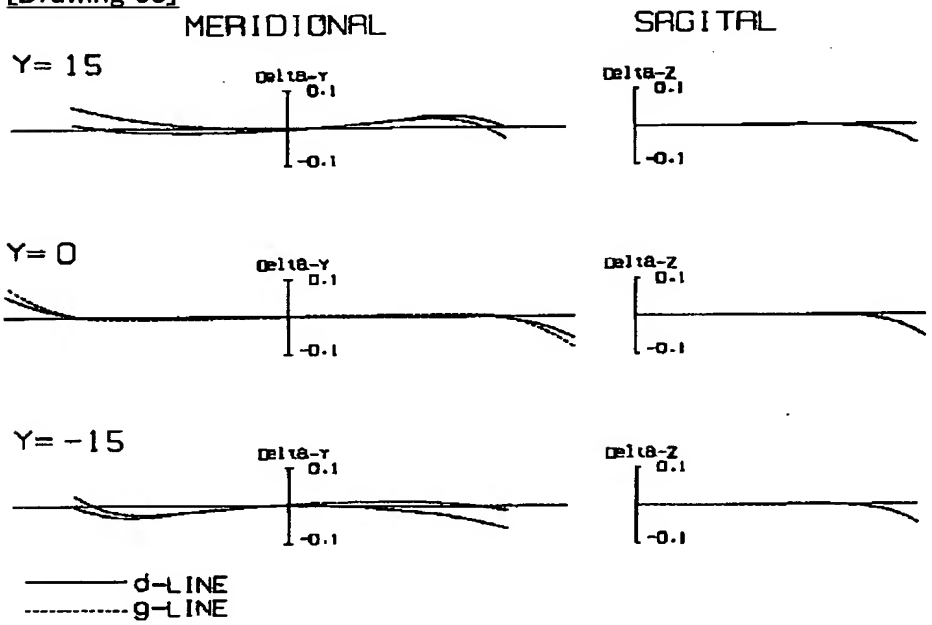

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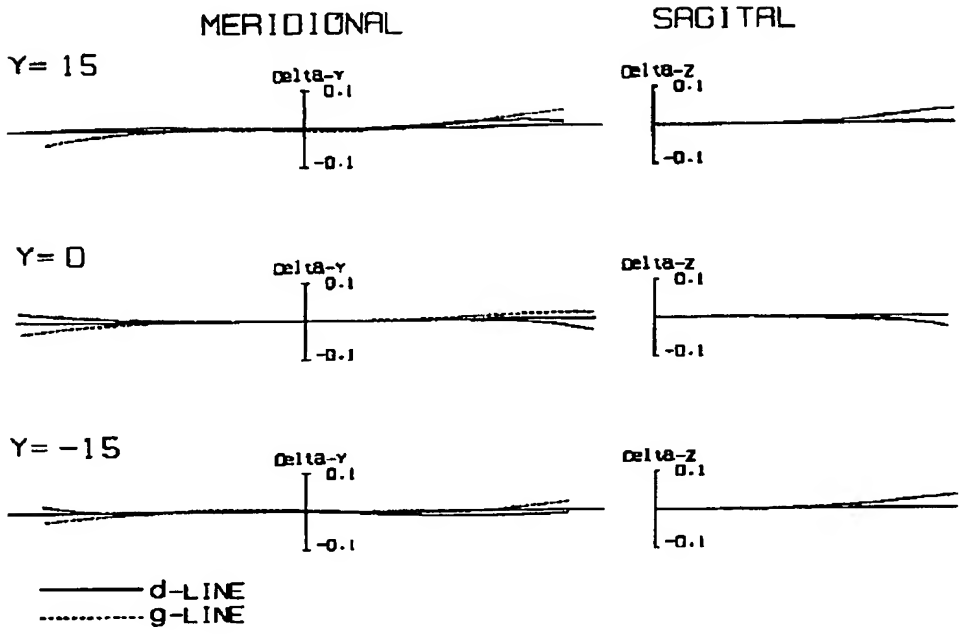

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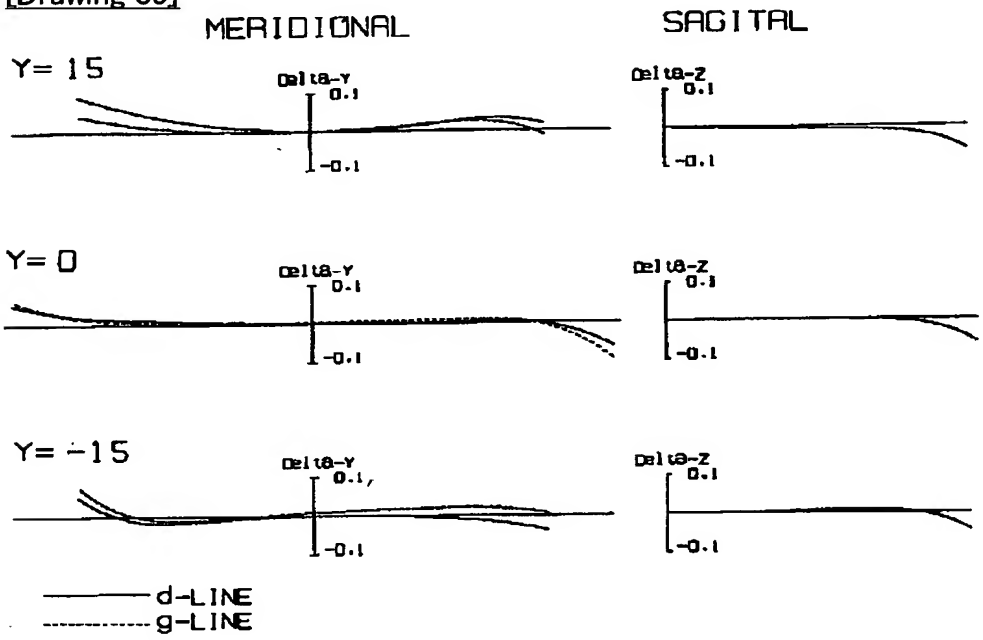

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